

Response to Reviewer 1 Comments for manuscript entitled: “Hydrologic Model Parameter Estimation in Snow-Dominated Headwater Catchments Using Multiple Observation Datasets”

North et al., in review at HESS

Reviewer 1 Comments

I reviewed the manuscript “Hydrologic Model Parameter Estimation in Snow-Dominated Headwater Catchments Using Multiple Observation Datasets” by North et al. This study investigates the value of integrating diverse observational datasets (streamflow, satellite-derived snow, soil moisture, and evapotranspiration) for parameter sensitivity and estimation in the pywatershed hydrological model across four snow-dominated headwater catchments. Using Morris screening and Monte Carlo filtering, we find that while alternative observations consistently identify more informative parameters than streamflow alone, their impact on final streamflow performance is highly catchment-specific. Only actual evapotranspiration (AET) data reliably improved simulations, whereas snow and soil moisture datasets yielded inconsistent results, sometimes degrading performance. The work underscores the context-dependent utility of multi-observational calibration, highlighting challenges such as equifinality, spatial representativeness, and model-observation alignment that must be addressed to effectively leverage new data sources in hydrological forecasting.

This is a timely, well-executed, and intellectually rigorous study that makes a valuable contribution to the field of hydrological model calibration. The experimental design is robust, leveraging state-of-the-art sensitivity and uncertainty analysis techniques (Morris method, LHS Monte Carlo filtering) applied to a relevant and modern modeling code (pywatershed). The manuscript is clearly written, and the analysis convincingly demonstrates both the potential and the pitfalls of integrating diverse, often spatially mismatched, observational datasets. The conclusions are supported by the data presented. I only have a few specific comments in the annotated manuscript file for further clarify the narrative and implications of the work. I would recommend publication after minor revisions.

AC1 Thank you for this review. We’re glad to hear that you found the study to be a valuable contribution to the hydrologic modeling literature. We’ve incorporated your detailed comments from the annotated PDF, and we reply to the comments that are more complex than simple typographical edits below. In our responses, we have denoted reviewer comments in italics and our responses in plain text.

Detailed comments

Figure 1: Why not putting them in one panel so that there will be four panels left in Figure 1. In this case, the panels may align better?

In the revised manuscript, we will update Figure 1 to ensure that the panels align better.

Figure 2: This [black squares and triangles] should be displayed in a legend in the figure.

We will update Figure 2 to add a legend representing these graphical elements.

Figure 3: I would suggest to show the original value on the color bar rather than the log values.

We will update Figure 3 to show the original values, but log the color scale.

Line 208: related to what? Cold, wet conditions?

We will update this text to read: “For example, `jh_coef` was more sensitive in warm, dry conditions than in cold, wet conditions.”

Line 306: What is the significant level?

We use $\alpha = 0.05$ and have updated the manuscript to reflect that.

Figure 5: Perhaps a better name that can reflect the intersections?

We will update the legend to “Observational calibration target”