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Hydrology and Earth System Sciences Discussions

Interactive comment on "The impact of land model structural, parameter, and forcing errors on the characterization of soil moisture uncertainty" *by* V. Maggioni et al.

Anonymous Referee #2

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Review of "The impact of land model structural, parameter, and forcing errors on the characterization of soil moisture uncertainty" by Maggioni et al.

This is an interesting paper that addresses an important topic in hydrologic modeling. The study integrates various state-of-the-art remote sensing products with a well documented hydrologic model. Yet, the inference methodology used herein to characterize and analyze model parameter and predictive uncertainty is rather weak. The GLUE methodology has found widespread application and use in the past decades, but is a rather weak inference methodology. I have several comments that I hope the authors appreciate and can use to further improve their paper.

1. The authors use the wording “model uncertainty”. I am confused – more detail is required what the authors consider to be “model uncertainty”. Some refer to this as the total uncertainty of the model. So, this includes input (forcing) data uncertainty, model structural errors, calibration data errors and parameter error. Others use a more detailed characterization and refer to “model uncertainty” as that part that stems solely from structural inadequacies to the model. In light of the GLUE methodology used, I believe the authors refer to the first definition and this should be made more clear. The GLUE methodology cannot be relied upon to “finding” the appropriate parameter values. Various contributions to the literature have demonstrated this. In other words, a large part of the model uncertainty actually constitutes parameter uncertainty. Also the GLUE methodology does not attempt to separate out different error sources – all uncertainty is represented as parameter uncertainty. This is a major weakness that prevents scientific progress.

2. The sensitivity methodology appears to be a local one. One parameter is varied at a time. Such method ignores possible parameter correlations.

3. Page 2292 – Line 23: I strongly disagree with this statement. GLUE is not an objective method. The cutoff threshold, and likelihood function used are entirely subjective. Moreover, the simple sampling method used to sample the prior parameter space is misleading, and cannot be relied upon for finding the “posterior” parameter estimates. Work by Blasone et al. (AWR, 2008) has introduced a better sampling methodology to at least resolve the sampling inefficiency of GLUE. I suspect that the use of such improved posterior sampling method will alter the major findings of this paper, as I do not trust the statistics and results obtained herein with all the weaknesses of GLUE documented in the literature.

4. Page 2296 – Line 12: “non-parametric”. GLUE actually has several variables that need to be defined by the user. This includes the cutoff threshold, the sampling size, and the likelihood function used to partition between acceptable and non-acceptable parameter values. It cannot be referred to as non-parametric. Also, the procedure is

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not really mathematical. It is brute force Monte Carlo sampling, with little mathematical rigor.

5. Given the strengths of the forcing data and the model used, I am surprised that the authors have decided to use such a weak method as GLUE in their analysis. A more rigorous Bayesian approach would have made the paper much stronger and less timely. An advanced MCMC simulation scheme, and generalized likelihood function that accounts for structural error explicitly would have provided more inspiring results.

6. If the focus is on ensemble forecasting, then why not use model averaging methods such as BMA? This method would have done the job, without having to sample the parameter space. The different forcing data sets could simply be run through the model and their posterior weights are computed by maximizing the likelihood against the observed data. The weights derived this way could then be applied in a forecasting mode. This approach would have been computationally cheaper, and probably would have resulted in sharper predictive uncertainty intervals.

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