

HESD review

Inverse modeling of hydrologic parameters using surface flux and runoff observations in the Community Land Model
Sun et al.

General comments

The paper applies an inverse modelling approach based on MCMC for estimation of parameters in a land surface model. Inverse modelling is a well-established discipline within hydrological modelling, and the applied MCMC approach has been previously introduced for parameter estimation in this area. Thus, methodology-wise the paper does not make any new significant contributions to the research area.

The paper is not fully to the point and lacks technical soundness for some parts in the presentation:

1. The authors state that they 'compare the performance of two different inversion strategies, including deterministic least-square fitting and a stochastic Bayesian inversion approach' (page 5080, line 26-27). However, the paper only presents results of application of the Bayesian inversion approach.
2. In the formulation of the Bayesian approach multiple data types are considered. In addition, the paper discusses multi-objective calibration in the Introduction. However, only one data type is considered for calibration in the three test cases.
3. The results seem to be very sensitive to the acceptance probability of the MCMC algorithm. The reasons for this behaviour are not fully explored in the paper, and are partly neglected in the discussion of the results. The behaviour indicates that the inversion method is not very robust.

Detailed comments

1. Page 5082, line 18. Are these the parameters that were found to be sensitive in the previous studies by the authors? Were they all sensitive with respect to both flux and runoff?
2. Page 5083, line 5. Very brief reporting of the PEST application results, which does not make any sound contribution to comparison with the MCMC approach. Did the authors further analyse PEST, e.g. by tuning algorithmic parameters, check of convergence, and using different initial parameter sets?
3. Page 5083, line 17. PEST also provides an estimate of parameter and model predictive uncertainty.
4. Page 5084, line 6. Typically, in hydrological model calibrations residuals are dependent, which should theoretically be included in the likelihood function. What is the impact on the results of the independence assumption?
5. Page 5084, line 18. Provide a reference to the Metropolis-Hasting sampling method.
6. Page 5085, line 17. This statement seems to contradict the previous discussion of the PEST results.
7. Page 5086, line 20. The purpose of the Bayesian modelling averaging is not clear. Model results using different sampling parameters are averaged. Theoretically this can be done, but does it make any sense?

8. Page 5087, line 6. This applies for all inversion methods, and if actually new information is included by the additional data. In general, it is better to include new data of another type (or from another location) rather than more data of the same type (from the same location).
9. Page 5088, line 9. This seems to be a very small number of samples retained for estimation of the posterior distributions. And may have a large impact on the results. Was sensitivity studied applied to look on the sampling variability?
10. Page 5091, line 21. What does 'reasonable' mean? Compared to using monthly data?
11. Page 5092, line 3. Is it the same subset of parameters that are most sensitive to both flux and runoff?
12. Page 5094, line 9. The reason for analysing the impact of temporal resolution of observation data is not well explained. If you are only interested in output on a monthly time scale (which is the results presented), then there is no reason to use data with a finer temporal resolution. Obviously, if results on a daily time scale are required, daily data should be used for the calibration.
13. Page 5095, line 25. Sentence not clear.
14. Page 5096-5097, Sections 6.5 and 6.6. New results are presented. Should be moved to Results section.
15. Page 5104, Table 1. Something seems to be missing in 'Used equations from'. Explain STD.
16. Page 5113+5115, Figs. 9+11. Which acceptance probability is used?
17. Page 5114+5116, Figs. 10+12. The 10-parameter solution could be included for a direct comparison.