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Comment on hess-2021-514

Anonymous Referee #1

Referee comment on "Pitfalls and a feasible solution for using KGE as an informal likelihood function in MCMC methods: DREAM$_{(ZS)}$ as an example" by Yan Liu et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-514-RC1, 2021

The authors proposed an informal likelihood function based on KGE (with modifications), and demonstrated its performance against a formal likelihood function based on RMSE in DREAM_ZS with three cases. There are several key questions that were not clearly answered.

- Why should one use the KGE-based informal likelihood function? Why Gamma distribution? It seems that it is not advantageous over the formal likelihood function in the three case studies. It would be essential to design a case where the formal likelihood function would fail while the KGE-based one still works. Simply introducing a new metric (without solving challenging problems) has no significance.
- No theoretical analysis has been provided. At least one case where analytical form of posterior is available should be considered to verify whether the new likelihood can obtain the right answer.
- The numbers of unknown parameters are generally small. A case with more than 20 unknown parameters (>100 would be better) is suggested to demonstrate its performance in more challenging settings.
- Comparison with other informal likelihood functions (NSE, GLUE, etc.) is lacking.

Minor comments

- Lines 47-48: confused about what is N about.
- Lines 57-60: The proposal should not affect the shape of posterior if the chain is sufficiently long.
- Line 82: if the types of observations are different and with different magnitudes, how to calculate the ED metric?

- There is no need to include results of KGE_ori, as they are obviously wrong.
- Figures 6 (h-g), curves of KGE_ori and formal are quite different, why? A synthetic case with similar settings is needed to check which one failed to capture the truth.
- Line 364: capable to->capable of
- What is equation of the likelihood function based on RMSE? There are also many forms of formal likelihood function (e.g., Table B1 in J.A. Vrugt / Environmental Modelling & Software 75 (2016) 273e316)