

Interactive comment on “Bayesian Inference and Predictive Performance of Soil Respiration Models in the Presence of Model Discrepancy” by Ahmed S. Elshall et al.

Anonymous Referee #1

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The paper evaluates the impacts of statistical data assumptions in soil microbial respiration modeling on estimated model parameters and on model predictions. Inference is done using various soil respiration models and various likelihood functions, using half-hourly CO₂ flux data from a field site. It's an interesting study, but I suggest additional effort to clarify and increase contribution of the work.

1. Contribution: the authors should more clearly spell out the explicit contributions of the paper. On the one hand, the methodology is not new and has been developed and applied in hydrological studies. On the other hand, the application to CO₂ modeling may also not be entirely new since the likelihood approach used here has already

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been applied to ecological modeling (including carbon flux modeling); a recent example is Scholz, K., Hammerle, A., Hiltbrunner, E. et al. *Ecosystems* (2018) 21: 982. <https://doi.org/10.1007/s10021-017-0201-5>.

2. The authors find some problems with the estimation of autocorrelation and suggest an alternative approach (Evin et al.). Why not test this approach as well? I'm not sure this would warrant a separate publication. Including it here would enhance novelty of the paper in my opinion. Note also that the high temporal resolution (half hourly) of the data used by the authors may be a complicating factor; see the following paper that discusses this: <https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-406/>.

3. The paper should be checked for various grammatical errors and typos. One example is "heteroscedasticity", which is spelled in multiple creative ways throughout the paper.

4. Description of the various evaluation metrics seems better placed in the methods than results section.

5. Terminology: the distinction between model fidelity and discrepancy is not clear

6. Line 305, "discrete proposal distribution": I don't think the proposal is discrete, it is a proposal distribution over a continuous parameter space.

7. Line 477: please rephrase; I don't think it's "expected" that accounting for autocorrelation leads to biased parameter values. I would expect the opposite, since autocorrelation provides a (simple) way to account for model errors.

8. Eq. 23: is index i an index over time or is it an ensemble index? Please clarify.

9. Line 598: approaches that use "total residual error" typically still separate out parametric uncertainty, so the residual error includes measurement, model input, and model structure uncertainty, but not parameter uncertainty.

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