Interactive comment on "Bayesian integration of flux tower data into process-based simulator for quantifying uncertainty in simulated output" *by* Rahul Raj et al.

Anonymous Referee #2

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The manuscript "Bayesian integration of flux tower data into process-based simulator for quantifying uncertainty in simulated output" by R. Raj et al. presents a calibration experiment of six process parameters of the BIOME-BGC terrestrial ecosystem model against GPP data derived from eddy-covariance flux tower measurements. The presented diagnostics (RMSE and NSE) show that the simulation of GPP using the posterior parameter set has improved compared to the prior values. The concept of Bayesian parameter calibration in ecosystem models is not new and has already been demonstrated in many other studies also using eddy-covariance flux tower measurements, but so far has not been applied to BIOME-BGC.

Although the manuscript is mostly well written and rather concise in the presentation of

the methodology it cannot be published in its current form. There are several problems.

The main problem of this manuscript is the use of time-varying parameters. The authors themselves recognise this as a problem (see page 13, lines 11/12). If I understand their use of time-varying parameters correctly ('engineering' a times series of GPP based on independent monthly sub-time series) it actually violates Bayes theorem, mass conservation and model dynamics. Of course one can do such an experiment to better understand the model dynamics and identify missing or mis-represented processes, but the authors are not taking this step and analysing the consequences of their results with the time-varying parameters in terms of model structure and formulation.

Another concern is the use of GPP derived from eddy-covariance flux measurements as the observations in the calibration process. Eddy-covariance towers measure the net exchange flux, essentially NEE, and GPP is the derived from this net flux by employing a model. So essentially, the authors calibrate the BIOME-BGC parameters against another model, in this case the NRH model which makes its own assumptions about the dependency of GPP on environmental conditions.

The whole Section 4.4 is not needed and does not provide any new insights, it is obvious that a dynamical model with state variables such as BIOME-BGC then also depends on its state variables.

So essentially the remaining part of the manuscript concerns experiment 1 and becomes rather light-weighted as a thorough analysis of the results from experiment 1 is missing. For example, how does the posterior error covariance matrix look like and what consequences does this have on the parameters (identifiability) and model? How does the posterior uncertainty compare to prior uncertainty? What is the impact of the observations on other simulated quantities (NEE, NPP), both in terms of their mean and uncertainty? How does the variability and the temporal autocorrelation compare to the prior?

Also the terminology used in the manuscript is somewhat confusing. Sometimes the authors refer to simulated, sometimes to predicted GPP and sometimes to predicted flux tower GPP. In that context they also use the phrase 'posterior flux tower GPP', it is not clear to what the posterior refers?

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