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Interactive comment on “Parameter-induced uncertainty quantification of soil N₂O, NO and CO₂ emission from Höglwald spruce forest (Germany) using the LandscapeDNDC model” by K.-H. Rahn et al.

Anonymous Referee #1

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Overall assessment

This study aims to quantify parameter uncertainty for a model LandscapeDNDC using observational data from a spruce forest site Hoglwald. In doing so the authors have learned more about how the model parameters are related which aids their understanding both of how the model works and also to the extent that the model is an accurate

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representation gives further insight into biogeochemical processes of a spruce forest ecosystem. They go on to quantify how the remaining uncertainty in the parameters feeds through to uncertainty in the outputs which they compare against the original calibration data and another later dataset which was not used in the calibration. While a lot of this is not so novel given recent papers (for example van Oijen et al. 2011) the authors do go into more depth in their analysis of the relationships between model parameters and the strength and weaknesses of the model with a quantification of uncertainty against observations. Thus this reviewer considers there to be sufficient new analysis to make the study worth publishing.

The approach taken is a good one by applying the mathematics of probabilities to estimate the conditional probability of the parameters being correct given the data. This is done by applying Bayes theorem and using the method of Markov Chain Monte Carlo (MCMC) as an efficient way of sampling the posterior. The authors make a pragmatic decision to only look at parameter uncertainty in a submodel. This is a limitation however the authors are honest about this and they consider its implications in a balanced way in the discussion. In addition the paper is well presented with good informative figures which are clear and help to make the points that the authors are making.

Unfortunately the implementation of the MCMC is incorrect. Thus the results of the paper (as it stands) cannot be considered to be valid and would have to be corrected before the paper could be considered for publication. The authors apply a Gelman-Rubin convergence criterion but they only apply it to a portion of the chain and so are misled into believing that the chain has converged. Looking at parameter EFFAC figure 4b it is apparent without the need to calculate Gelman-Rubin that the MCMC chain has not sufficiently converged. For a converged chain all four chains would need to agree on either one or other of the modes or the bimodality. (As an aside in the experience of the reviewer bimodalities for models of this type are rare.) Bayes theory does not allow for more than one joint posterior probability (i.e. chains which disagree

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about the location of the posterior) so the results as they are cannot stand. Indeed the authors themselves state p5257 line 18 "it is not possible to draw any statistical inference from the sampled parameter vectors if the Markov chain has not converged (Gilks et al., 1996)." This unfortunately invalidates the rest of work. In terms of Gelman-Rubin it is the the part of the chain that is considered to sample the posterior which needs to conform to Gelman-Rubin. The authors can revise this work by running the MCMC chain out for longer and demonstrating convergence using Gelman-Rubin for the posterior portion of the chain rather than just part of the burn-in.

Minor corrections

- Should be joint not joined parameter distribution (changes needed throughout)
- p5251 line 15 need -> needs
- p5253 line 26 does the soil-chemistry really describe all the processes relevant for C and N trace gas production? What about the influence of the plant for litter production and available N uptake for example.
- p5254 line 23 this is too strong parameter vectors which comply are only more likely to be accepted by the algorithm. Its still a random process.
- p5255 line 14 run -> ran
- p5255 line 28 limited to explaining the models linear behaviour only
- p5257 line 4 this is only really an error if either the model or the observations can considered to be closer to the truth instead it is a difference.
- p5259 line 18 see point made above error -> difference

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- p5265 line 24-29 This is really not valid reasoning each chain must find the same posterior. Bayes theory does not allow for more than one posterior.

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