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Geoscientific Model Development Discussions

Interactive comment on "Identification of key parameters controlling demographicallystructured vegetation dynamics in a Land Surface Model [CLM4.5(ED)]" *by* Elias C. Massoud et al.

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Identification of key parameters controlling demographicallystructured vegetation dynamics in a Land Surface Model [CLM4.5(ED)] Elias C. Massoud et al.

This paper uses the Fourier Amplitude Sensitivity Test (FAST) method to perform a parameter sensitivity study for the CLM4.5(ED) model. The study simulates the variance range and first and second order sensitivities for particular diagnostics relative to parameter perturbations drawn from uniform sampling within $\pm$15% of the model default values for 87 parameters, including biophysical (including temperate response), allometric, allocation, reproduction and establishment, mortality, leaf optical, leaf longevity

parameters, and a "competitive exclusion" parameter. The study is performed for one PFT at an Amazon forest site with 25 years of recycled meteorological forcing at 1°x1°, with 5000 simulations (a little less than the $\sim$100 x number of parameters called for by Xu and Germer, 2011, so it seems $\sim$37 of the 87 parameters were not "important") 130 years in length.

This study serves more as a template and foundation for further work to perform later parameter optimization and more rigorous analysis relative to data, so as such it provides good documentation of methods of setup and analysis. The authors largely acknowledge typical concerns about the shortcomings of sensitivity studies like this, including that the parameter sampling is not based on observed distributions, only one PFT is simulated, and the mortality sensitivity to hydraulic failure is not a model sensitivity but rather a site meteorological forcing result. The choice of this particular site was obviously just expedient based on available drivers, so this reviewer views the study more as preliminary setup and test of concept, rather than new findings about DGVMs or about nature.

While the results are largely confirming what is already known about the model, such as the overshading of understory trees with the PPA, and the non-linearity of responses by tree size (and some of the results could have been obtained analytically from the equations in the DGVM), the technique illustrates a method quantitatively to stratify or rank the sensitivity of a diagnostic by parameters in a way not available through just Monte Carlo sampling.

For the sake of a sensitivity analysis method, the authors should add more to the discussion about the following:

1) Whether the 25-year periodicity of the meteorological forcings (very apparent in Figures 3c and 3d) affects the purported parameter sensitivity.

2) A little more explanation about the 30-year intervals chosen to average the sensitivity values. The authors say, "This is done in view that the transient and abrupt

changes across different size categories in the annual model outputs could make the FAST analysis only account for a minor amount of the variance contribution from each parameter." If the FAST sensitivities are a function of temporal averaging period, this is rather important to address! In that case, it seems running means and a spectral averaging approach would make sense to identify time scales of sensitivity. This perhaps is a missed opportunity to show something interesting in terms of the model sensitivity; e.g. there are model-dependent fast and slow processes updated at short time scales, some processes updated at longer time scales, as well as event–driven processes dependent on meteorological forcing.

3) For the sake of readers not familiar with FAST, how does the underlying distribution of parameters propagate to the calculation of the variance, the latter by definition assuming Gaussian distributions. Some sentences on this would be good to add, citing statistical theory papers, and not just application papers.

4) That the sensitivity values change with time and community structure, but the parameters do not change their relative rank to each other: is this a result of the model structure (one PFT, fixed sensitivities in the physics) or a result of the site meteorology?

5) A suggestion/question: Is it possible to do surface analysis of two-variable sensitivities, and would that reveal any useful relations?

Other small things to fix: Section 1 of the paper needs to be proofread for grammar and subject verb agreement. There are a lot of sentences that are a bit sloppy. After the Section 1, this problem disappears! Overall, the paper is clearly written, well-documented, figures illustrate results well. As the Holm et al. (2018, In Review) paper cited picks up where this paper leaves off with data on the parameter distributions to provide for some quantitative understanding of the system being profiled, this paper by Massoud et al as primarily a methodological exercise is fine for a journal like GMD.

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