

Author responses to Anonymous Referee #1 (Responses in Blue)

Summary: Koven and co-authors presented a model-observation comparison and parameter sensitivity analysis of a new vegetation model with explicit demography, FATES. They performed ensemble simulations in which plant traits defining plant functional types were randomly selected from observed distribution from the field site in Panama. They assessed the effect of plant traits and disturbance parameters (i.e. competition rules) on ecosystem variables. They showed that increasing the number of competing PFTs in ensemble simulations strongly shift model predictions and that model outputs show different sensitivity to different parameters depending of that number of PFTs. They also showed that modifying competition rules shifted dominance regimes and coexistence between PFTs. They concluded that a differentiation between plant traits influenced or not by competition should be made to quantify the sources of uncertainty in vegetation demographic models.

Major comments: Despite I found this manuscript sometimes difficult to read, I really enjoyed the approach and the analysis presented in this paper. Representing plant trait variability is a very challenging, but necessary task for building the next generation of vegetation models, and this paper will be a very useful contribution for the modelling community. I only have a few comments that could help to improve the readability of the paper:

We thank the reviewer for their careful review and positive assessment of the manuscript.

- The number of traits and simulations performed in this manuscript made it difficult to follow sometimes. Some additional information could help understand the sensitivity of the model. For example, a table linking plant traits to the main processes of the model could help understand better the sensitivity results. Also, a better description of the experiments performed and why it was performed can improve the readability of the manuscript. Descriptions in Table 1 are not clear enough.

In the revised manuscript we will either either a more information on the meaning of the parameters and why they were chosen into table 1; and/or include a box-and-wire process diagram, with some details of how some of the traits used here fit in to different aspects of the model, so as to provide an overview of why we selected these traits.

- In my opinion, the comparison between ELM and CLM does not bring any interesting information to the paper if the authors don't highlight the main differences in processes. The only conclusion you can draw here is that if you use a different model, you have different results. . . . It is not informative and a bit disconnected from the trait sensitivity part.

We agree with both reviewers that the justification for this analysis was not sufficiently made in the submitted draft. We do feel that this is important to include in the manuscript, because this approach of modularizing a distinct component of the land surface into a separate codebase that can be called by multiple LSMs (and ESMs) represents an important strategy in managing process complexity and shifting away from a model-centered approach and towards a hypothesis-centered approach to experimental design in simulating the land

surface. It is thus important to document the dynamics of FATES within each of the LSMs it currently works within in order to test the hypothesis that such an approach is valid. We will add further discussion of this point in the revisions, as well as linking to a separate manuscript by authors RAF and CDK, which explores this point in further detail and is currently in review.

- It would also help the reader if a small discussion on the effect of allometric relationships that are described in the method section.

We still haven't fully explored these differences in the model, and leave this as future work. We will discuss this point in the revised manuscript.

- We have a good description of trait data used in this paper; however, we don't have any description of sites characteristics (age, diversity, disturbances, ect. . .). It is difficult for the reader to assess the performance of the results, and the comparison of results with site data is not really informative because of that. Also, is the model previously parameterized to run on that particular site?

We'll add more info on the site in the revised version of the manuscript.

- We don't have information about the method used to randomly select traits in the 12x12 matrix. Why these particular traits? For each trait, is the selected value weighted by the distribution? Is only the range of the distribution used? What if you make a simulation by taking the median value of each trait? How are you sure that the whole trait-space is used for the sensitivity analysis? Especially when you increase the number of PFT, you virtually increase the trait space, which can create a bias if you compare the same number of simulations (576) for 1, 3 or 10 PFTs. Also, I was wondering if it is relevant to randomly select set of traits since we know that trade-offs exist between some traits. It means that sometimes you run the model with a set of traits that has no ecological sense. In that case, is it not better just to make a classical sensitivity analysis by varying parameter values incrementally, or at least to constrain some traits based on the known trade-off?

We randomly sample the traits, assuming either normal or lognormal distributions for all traits, and allow any covariances that exist in the data to be propagated into the trait sampling. Because of the nonzero covariances and (for some traits at least) known trait distributions, we chose the method that we use here.

- Finally, I find that putting in parallel the benchmark and the sensitivity analysis dilute the key messages of the paper. The paper can be strengthened by mainly focusing on the sensitivity of the simulated plot characteristics to traits variability in the light of known ecological properties of the forest. For example, are the observed shifts driven by plant traits consistent with our ecological knowledge of the forest functioning? Here it would be more interesting to show that the FATES model is able to reproduce the expected ecological behavior of the forest, and if not to explain through the sensitivity analysis which parameter or process is missing or poorly represented.

We want to combine benchmarking and parameter sensitivity together in order to (a) establish the usefulness of the model for describing the ecosystem, and (b) because the agreement of model predictions to observations are important in understanding some of the sensitivity questions that we explore in the manuscript, such as in sections 3.3 and 3.4.

I hope the authors will find my comments useful to improve their manuscript. Best,
Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2019-409>,
2019.

We thank the reviewer for their comments.