Geoscientific Model Development Discussions

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Comment on gmd-2021-410

Anonymous Referee #3

Referee comment on "The impact of hurricane disturbances on a tropical forest: implementing a palm plant functional type and hurricane disturbance module in ED2-HuDi V1.0" by Jiaying Zhang et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-410-RC3, 2022

Summary

Cyclonic storms are one of the major natural disturbances in tropical forests, and the intensity of tropical cyclones has been projected to increase over this century. Characterizing hurricane damage and post-hurricane recovery is critical for estimating forest resilience and the fate of tropical forests. This study implements a new hurricane module in a dynamic vegetation model, the Ecosystem Demography model (ED), to account for hurricane-caused tree mortality and post-hurricane recovery, which is primarily driven by wind speed, forest structure, and functional diversity. The study also added a new plant functional type for Palms, which can differ from other dicot tropical tree species in terms of ecophysiology and responses to hurricanes. The study performs some model sensitivity tests using GLUE and provides much detailed information on the methodology and results. Altogether, the study highlights the importance of representing the hurricane effect in terrestrial biosphere models.

Comments:

The manuscript provides a comprehensive model calibration and sensitivity analysis within the framework of GLUE. The materials and methodology are clear. Major comments are listed below.

First, the hurricane module is way less discussed in the study compared with functional diversity, and the Palm PFT despite the title focusing more on hurricanes. The method section describes a general framework to include hurricane module (i.e. link hurricane damage to hurricane intensity, forest structure, and species diversity). However, it is not clear what is the uncertainty/biases associated with the framework, which I believe can be large. For example,

- the key relationship in the hurricane module is parameterized by only two points (Fig. 1) and the low hurricane mortality for early successional big trees (Fig. 1b) is somewhat suspicious when the large tree fraction is small.
- Shouldn't Palms have generally lower mortality compared with other PFTs under hurricanes?
- It is also mentioned that partial crown damage is prevalent under hurricanes, which is not included in this framework and not even discussed.
- What are the key hurricane-related parameters that make the model capture changes in stem density and composition? (Fig. 4)

Given the title, readers would expect some in-depth exploration/discussion of the hurricane module and parameterization. Therefore, I would recommend including more sensitivity tests for the hurricane module or changing the title and intro to focus on Palm PFT.

Second, the GLUE trait optimization seems to be quite sensitive to light-related parameters. For example, the equilibrium clumping factor has a rather low value (< 0.4 while reported values are >0.6 over tropical forests). Quantum efficiency and dark respiration are dominating the variance (Fig.8). I think this might be because the canopy structure and light environment of the model are highly biased. Fig.S2 shows the initial LAI can exceed 8 (constrained by observed demography I guess?), which is rather high. This might explain why optimal Clf is so low and can be caused by biases in allometry (in fact, the allometric parameters can have huge effects but are not tested in the study). Meanwhile, this model does not consider acclimation to understory light. It is understandable that fully addressing these issues is challenging but they need to be acknowledged and discussed.

Third, the hurricane impact and recovery simulations are interesting but are

underexplored. Why only look at the impacts on equilibrium forest structure? Shouldn't the time scale be the average return interval of hurricanes in Puerto Rico? What about using additional initial conditions by sub-sampling different plots?

Minor comments:

Line 55 : the transition from hurricane impact (the previous paragraph) to functional diversity/PFT (this paragraph) seems somewhat abrupt. Some elaboration about why palm is unique, or why we need to incorporate this particular PFT in the context of hurricane disturbance will be helpful, e.g., the relative abundance of palm in hurricane-prone sites. And this information about palm should probably come before the explanation about early and late-successional species (line 58).

Line 69-71: we define a Palm PFT --> there is a need for a separate Palm PFT.

Line 85-86: maybe specify the version of ED2? ED-2.2 if citing Longo et al. 2019.

Line 159: Fig.2 uses time since disturbance to modify external seed rain rate (not seedling density). This assumes the recovery time scale is a constant. Why not use total LAI/BA? Early PFT seed rain can be high when LAI/BA is low but decreases when LAI/BA is high. This would be more ecologically meaningful.

Line 197: the definition of clumping factor is wrong. Should be effective LAI divided by total LAI.

Line 208-210 Any explanation for choosing stem density/DBH growth/BA as target state variables? Why not include mortality? There are large discrepancies between simulated mortality (almost constant across years) and observed mortality (large inter-annual variability) in Fig. S5

Line 328. Fig. 3. Are black dots observations or simulation? No information is provided in the caption. If they are observations like Fig. 4, what are the error bars, cross-plot variance? Also, I wonder how sensitive the results are to the length of training years. What about using half of the period as training?

Citation: Some of the most important information in methodology (such as allometric parameters, line 101) cite studies that are in review or in revision, and the paper only provides minimal information about them. There should be at least a brief description.