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## **Comment on gmd-2022-87**

Anonymous Referee #1

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Referee comment on "Developing a parsimonious canopy model (PCM v1.0) to predict forest gross primary productivity and leaf area index of deciduous broad-leaved forest" by Bahar Bahrami et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-87-RC1>, 2022

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### **Developing a Parsimonious Canopy Model (PCM v1.0) to Predict Forest Gross Primary Productivity and Leaf Area Index**

General comments:

Bahrami et al. developed a forest development model requiring few parameters linked with a phenology submodel predicting gross primary productivity (GPP) and leaf area index (LAI). They evaluated model performance at a selection of FLUXNET sites and performed a parameter sensitivity analysis determining the most sensitive parameters and optimal site-specific values as well as a set of compromise parameter values for larger regions. The model can be coupled with a hydrologic model, which could improve both water and carbon flux simulations.

The model is well developed and performs reasonably well at broad-leaved forest sites. The language and description of certain parts of the manuscript, however, should be improved before publication. Especially the Introduction and parts of the Results and Discussion are unclear and should be better explained. I would suggest rewriting most of the Introduction section to explain the cited literature and its relevance to the manuscript better. Generally, the model is explained well, but certain parts of the description can be made clearer (see specific comments below). The manuscript contains a lot of technical corrections (typos and grammatical mistakes), which should be corrected.

Specific comments and technical corrections:

- I. 5: Add "the" water cycle
- I. 38: Use "sequestering" instead of "sequestrating" (also in I. 69, 79).
- I. 43: In "60% of the global net forest sink" do you mean the "global net carbon sink"?
- I. 44: Specify what kind of ecosystems you mean; I haven't heard it defined as "vegetation GPP", just GPP. You could say "vegetated ecosystems". "Plant photosynthesis" already implies that it comes from vegetation.
- I. 45: GPP and ecosystem respiration are of similar magnitude and which one is larger depends on whether the ecosystem is a sink or source of CO<sub>2</sub>. I would rephrase this.
- I. 46: Be more specific what you mean with "has a direct effect on moderating climate and environment", especially the effect on the environment.
- II. 46-50: Be more specific about what "adverse effects of a changing climate" you mean! The second part of the sentence applies to any climatic conditions not only under a changing climate. To relate this part of the sentence to the first part about climate change, discuss its effects on temperature, water availability, radiation, etc. Otherwise, the reason for mentioning a changing climate here is unclear.
- I. 50: Favourable climate in what respect? I'm not sure what you want to express here and how, for example, the winter season is favourable for the vegetation.
- I. 51: "The plant canopy capacity and seasonality are expressed by leaf area index (LAI)" -> Rephrase this! What exactly do you mean with "plant canopy capacity" and LAI itself does not express seasonality. Changes in LAI do.

- I. 52: Reference? Maybe make it clearer that with "total green leaf area" you mean two-sided, as opposed to one-sided leaf area in broadleaf canopies, or total needle surface area in conifers.
- I. 53: Be more specific or add a reference here.
- II. 54-55: Rephrase this to make it clearer! Yes, LAI affects transpiration, but GPP does as well.
- II. 56-57: If you mention water balance components affected by LAI, I would include canopy evaporation as well.
- I. 68: Unnecessary to have both "later" and "in the next step". Could just say "in the dark reactions of the Calvin cycle, ...".
- I. 71: "specifically at scales larger than the leaf level" -> Above, you only mention that GPP is determined at the leaf level in the EK approach. You don't say how it is upscaled to the canopy level or larger scales.
- II. 76-77: Rephrase to make it clearer! It isn't clear that you mean that APAR is a product of PAR and fPAR, which is the biome-specific LUE parameter.
- I. 78: "The LUE" -> Say either "the LUE parameter" or "fPAR". You aren't talking about LUE itself here.
- II. 81-82: "CFLUX (Turner et al., 2006), EC-LUE (Yuan et al., 2007), MODIS-GPP (Running et al., 2004), VPM (Xiao et al., 2004), and CASA" -> Define what these abbreviations stand for!
- I. 86: Why specifically central Europe? If you mention it, explain why as well!
- II. 86-89: Unclear what you mean. Be more specific!
- II. 89-101: The purpose of this paragraph isn't really clear, as several different models are mentioned, but their limitations aren't clearly explained!
- I. 105: Explain what specifically you mean with "readily available observational datasets across eddy flux tower stations"
- I. 180: "changes of vapour pressure deficit" should be "changes in vapour pressure deficit".
- I. 200: It is unclear what you mean with "using the cumulative root fraction up to each layer". What is the cumulative root fraction used for, if the root fraction for each layer is multiplied by the soil moisture content of that layer?

- I. 228: "photosynthetical", not "photosynthetically"
- I. 251: Do you mean "growing season length"?
- I. 286: Why have "used" twice in the sentence?
- I. 288: It should be "BIOME-BGC" (also in I. 369).
- Equation 28: It should be 0 for  $T_c \leq T(t)$
- I. 339: Either use "we" or remove the "and" and add a ".".
- I. 342: Be more specific what you mean with "long missing data at some sites".
- I. 350-351: Make it clearer whether the soil moisture and soil texture variables are optional or required for the model.
- I. 359: "obtained" not "collected" via personal communication
- I. 360: Maybe say "s subset of 4 sites was selected based on data availability" instead of "based on the responses a subset of 4 sites are used".
- I. 364: What do you mean with "closest methods"? Are these methods both used at the same site or is one of the methods used at each site?
- II. 368-371: Explain the different water stress functions better instead of just mentioning their names.
- I. 375: It should be "in 2018".
- I. 390: In "the literature".
- I. 420: Do you not spin up the model for a longer time period? How can soil C and other C pools be spun up after one year or do you fully spin up the model with the default parameter values only?
- I. 466: "in (Eq. 3)" -> either remove the brackets or put the "in" into the brackets as well
- I. 468: Add "the" in front of "Farquhar photosynthesis scheme".
- I. 469: Add "the" in front of "photosynthesis process".
- I. 474: Switch order to "also showed".
- II. 474-475: Rephrase! I don't think you need both "typically" and "by default". Make it clearer what you're doing differently, if you mention that the parameters are "typically" fixed.
- I. 479: Instead of saying "the impact", specify what kind of impact (e.g., strong, weak) and say "VPD" or "the VPD variable".
- I. 480: It should be "the" next environmental factor constraining "GPP".
- I. 481: It should be "at the DE-HoH site".
- I. 484: Remove "the" in front of  $\theta_r$  (also in I. 486).
- I. 485: Add "a" in front of "soil matric potential".
- II. 487-489: Be more specific what you would use as parameters?
- I. 490: Remove "the" in front of "simulated GPP".
- I. 491: Add "the" in front of "LAI calculation".
- I. 497: Say "at some sites", not "in".
- II. 497-498: Either use just "b" or "The b parameter".
- I. 499: Add "the" in front of "temperature factor".
- I. 501: With "informative" do you mean "sensitive"?
- I. 502: It should be "favourable conditions".
- II. 504-505: "little impact of environmental stresses due to temperature on GPP during the growing season" -> What about outside the growing season? Are the temperature stress parameters just less significant than your phenology submodel parameters? Also, could this not be site-dependent? At some sites, heat might impact GPP during the growing season.
- II. 506-507: Rephrase to make your point clearer! Unclear what you mean with "a group of daily LAI".
- Close the bracket after Figure 5.
- I. 522: Why "might"? Do they?
- I. 527: Add "the" in front of "Fluxnet2015".
- I. 532: Explain what you mean with "allowing the canopy to reach to its maximum". Instead of "Next important contribution of parameters to the LAI output are those", maybe say something like "Other parameters the LAI output is sensitive to are ..." or "The LAI output is also sensitive to the parameters ..."

I. 536: "Lg parameter" -> Add "the" or remove "parameter".

I. 538: "cold accumulation in degree day" -> Below you call it "cold degree days". Choose one name and define what it is!  
Just say "leaf fall" instead of "the leaf fall event".

I. 539: "lower cold degree days accumulation" -> "Accumulated cold degree days"?  
Why does a lower value trigger earlier leaf fall?

II. 546-547: Make clearer what you mean! Why would LAI always decrease, when you change these parameters? Don't you vary the value by +/- 20%?  
Also, you say that GPP is less sensitive to these parameters than LAI, but then you explain the sensitivity of LAI by a reduced GPP?

II. 547-548: How is the sentence "Furthermore, the evaluation of Sobol' indices convergence (see Figure 4) showed relative stability of sensitivity indices at around 8 000 model evaluations." connected to the previous sentences?

I. 551: Instead of "informative parameters" maybe say "The X most sensitive parameters?"

I. 571: Instead of "validity" maybe use "performance".

I. 580: "where the model overestimated GPP" -> You mention poor performance due to a lack of soil moisture data and a lack of moisture. Why would GPP be overestimated then?

I. 599: Why was the decision made not to include non-structural carbohydrates in the model, if it is specifically made for deciduous broadleaf trees?

I. 602: "Eventually" is unnecessary.

I. 615: "also even" -> Use "also" or "even", not both.

Figure 1 caption: It should be "PAR: photosynthetically active radiation". Why do you define certain abbreviations that are in the rectangles but not all of them?

Table 1: You talked about excluding certain years with missing data. Are these the time periods you actually used?

Figure 5 caption: I think you mean "shaded areas". Why do you only have the shading for short periods at certain sites?

What ensemble are you talking about? Is it an ensemble of the model output using different parameter values?