

Response to Referee #2 comment (RC2)

We would like to thank the reviewers for taking the time to review our manuscript and providing constructive comments. Please see our responses to the comments below.

RC2:

Yoshikai et al. present a well-articulated analysis of a model development effort centered on capturing mangrove ecosystem structure and long-term carbon storage using the individual based dynamic vegetation model SEIB-DGVM with a newly incorporated plant hydraulics model following Xu et al. 2016 and a salinity regulation component following the theoretical works of Perri et al. 2018 and 2019. Impressively, the new mangrove function model also accounts for the influence of nutrient availability (specifically nitrogen) alongside plant hydraulics. The new model proved capable of convincingly reproducing the behaviors of two species of mangrove along a soil salinity gradient in Japan. On the whole, the manuscript presents a strong, timely, and necessary contribution to DGVM and Earth system modeling, given the unique dynamics of mangrove ecosystems and their outsized influence on the carbon cycle. I have only minor questions and suggestions for the authors as they ready their work for publication.

Response:

Thank you very much for the positive assessment and constructive comments on our manuscript. We have addressed the comments suggested by the reviewer, as follows.

RC2:

L160: The introduction of an aboveground root biomass carbon pool is a particularly useful addition to this model and other mangrove/cypress systems. I am curious how the aboveground root biomass was accounted for allometrically? Was this related more strongly with stem or crown diameters?

Response:

In the previous study of Yoshikai et al. (2021), the above-ground root structures of *Rhizophora stylosa* were extensively measured in our study site (Fukido mangrove forest), and an empirical model to predict the root morphology was established. The empirical model uses only DBH (diameter at breast height) as the explanatory variable. We used this model to compute the above-ground root biomass pool in the simulation, therefore it is related only to DBH. The data and empirical model prediction of DBH and above-ground root volume relationship are provided in Fig. R1.

As an action for manuscript revision, we will add an explanation about this point.

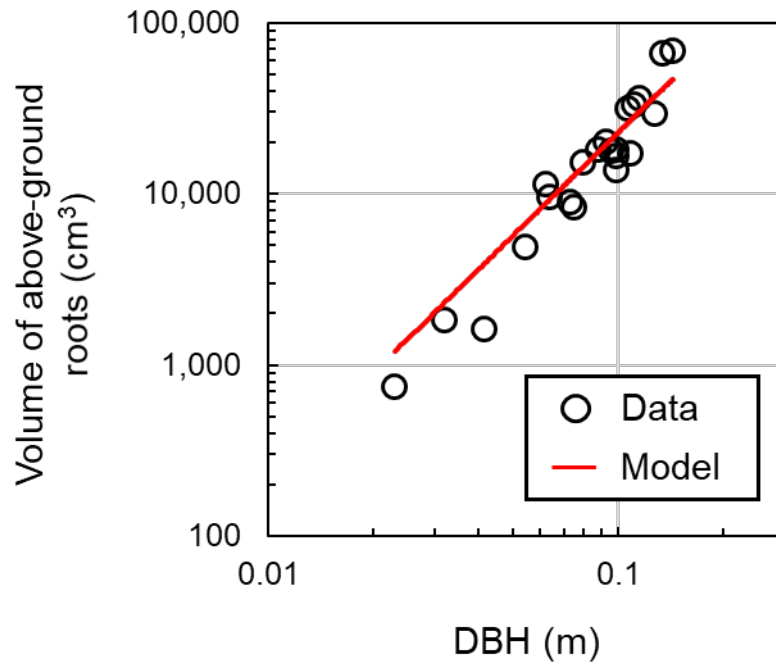


Figure R1. Relationship between DBH and above-ground root volume of *R. stylosa* measured in Fukido mangrove forest. An empirical model developed in Yoshikai et al. (2021) was used for the prediction.

RC2:

L195: Was the sapwood allometric relationship specific to the two mangrove species simulated in this study or is this a general equation?

Response:

We consider that this is a general equation. In the work of Trugman et al. (2019) on terrestrial ecosystems, they applied this kind of simplified relationship for estimating sapwood area and stated that the simplification is broadly consistent with reports in literature.

RC2:

L203: How was LAI measured in this study? Were different values used for the different species?

Response:

LAI has not been measured in the study site.

In L203, the leaf area, LA ($m^2 tree^{-1}$), is calculated using $M_L \times SLA \times 10^{-4}$, where M_L is the leaf biomass ($g tree^{-1}$), which is a state variable in the model, and SLA is the specific leaf area ($cm^2 g^{-1}$), which is a model parameter as shown in Table 2.

As an action for manuscript revision, we will include the statement that the simulated LAI has not been validated and will be considered for future study.

RC2:

Table 1: It looks like there are a few sources missing (e.g. $D_{crown,con}$ and H_{con}) what values were used for these and were they assumed or developed from literature or field observation?

Response:

Physical constraint on crown diameter ($D_{\text{crown,con}}$) and on tree height (H_{con}) are the variables to be computed in the SEIB-DGVM based on the relative distances of a tree with surrounding trees as illustrated in Figs. 3c–d. Therefore, there is no source and value to add in Table 1 for these variables. For the parameter β_{stock} (Target C and N in the stock pool relative to the stem), we gave an assumed value because we were not able to find any value from literature. The given value (0.05) is comparable to the value of model prediction of nonstructural carbohydrate reserves (NSC) and xylem biomass ratio in Trugman et al. (2018).

As an action for manuscript revision, we will indicate in Table 1 that the value for β_{stock} is an assumed value.

RC2:

L240: How were the values for critical leaf water potential determined? Were these values optimized?

Response:

Yes, the value for the critical leaf water potential was optimized for each species so that the simulated above-ground biomass (AGB) and mean DBH agree with the field data.

Relevant descriptions can be found in L312–314.

RC2:

L350: It would be useful to restate the present-day average salinity for comparison's sake.

Response:

Thank you for the suggestion. We will add a sentence after L. 350 that states that the present-day average salinity of the survey plots is 28 ‰.

RC2:

L367: More discussion of the simulated *B. gymnorrhiza* mortality would be useful and interesting. Was there a programmed lifespan that triggered this event?

Response:

L367 refers to the deaths of large *B. gymnorrhiza* trees that generated forest gaps and promoted the establishment of small trees under 20 ‰ salinity condition.

We did not prescribe any lifespan in the model due to the lack of knowledge on mangroves' longevity (the original SEIB-DGVM defines tree longevity as a model parameter, but this factor was excluded in this study for this reason; the relevant description can be found in L100–101 in the Supporting Information). We also did not introduce any specific processes for the death of large trees such as size- and age-dependent mortality (please see Note S3 in the Supporting Information for the processes related to tree mortality). Therefore, tree deaths occur without dependence on tree size or age in the simulation. On the other hand, only deaths of large trees generated forest gaps that promoted tree establishment because the deaths of small trees resulted in growth stimulation of the surrounding trees and the space created by the death were eventually filled by the canopy of the surrounding trees; this process can be seen in Fig. 8 showing the decreasing tree density with increasing individual tree biomass.

In this regard, we figured out that the term “onset of deaths of large *B. gymnorrhiza* trees” in L367 was confusing because it seems as if some specific processes triggered large trees' mortality. Instead,

we should have written it as “onset of formation of forest gaps resulted from deaths of large *B. gymnorhiza* trees” to convey our intention correctly. We are sorry about it.
As an action for manuscript revision, we will correct this point.

RC2:

L394: A figure citation here where this comparison is shown would be helpful.

Response:

We will add figure citation (which is Fig. 7b). Thank you for the suggestion.

RC2:

L510: At what time increment is the optimization of the DBH-H adjustment applied?

Response:

The morphological adjustment occurs at daily time step by the flexible biomass allocation as indicated in Fig. 2. The detailed procedures on biomass allocation are described in Fig. 3.

RC2:

L521: Does the increase in root biomass refer to both above and below ground roots or are the aboveground roots lumped into the shoot category in this scenario?

Response:

The statement in L521 refers to the result shown in Fig. 9. In the figure, the root biomass refers to the sum of coarse root and fine root biomass while the shoot biomass refers to the sum of stem and leaf biomass. Thus, above-ground roots are not accounted for in both shoot and root biomass in Fig. 9. The description about this point has been provided in the caption of Fig. 9 (L422–430).

RC2:

L579: It would be nice to see the code released with a DOI in a Zenodo repository or the like given the relevance of this modeling effort to the broader community of models.

Response:

We will consider to upload the codes in GitHub and include the URL in the revised manuscript after clarifying copy rights and improving the code readability. Thank you for your interest.

RC2:

Finally, there are a few instances of minor grammatical errors (subject-verb agreement and plurals versus possessives) that could be addressed through the use of a grammar editing service.

Response:

We are sorry about the grammatical errors. We will carefully check the manuscript again for the revision (this manuscript is actually a version after an English proofing service).

References

- Trugman, A. T., Anderegg, L. D., Wolfe, B. T., Birami, B., Ruehr, N. K., Detto, M., ... & Anderegg, W. R. (2019). Climate and plant trait strategies determine tree carbon allocation to leaves and mediate future forest productivity. *Global change biology*, 25(10), 3395-3405.
- Trugman, A. T., Detto, M., Bartlett, M. K., Medvigy, D., Anderegg, W. R. L., Schwalm, C., ... & Pacala, S. W. (2018). Tree carbon allocation explains forest drought-kill and recovery patterns. *Ecology Letters*, 21(10), 1552-1560.
- Yoshikai, M., Nakamura, T., Suwa, R., Argamosa, R., Okamoto, T., Rollon, R., ... & Nadaoka, K. (2021). Scaling relations and substrate conditions controlling the complexity of *Rhizophora* prop root system. *Estuarine, Coastal and Shelf Science*, 248, 107014.