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Interactive comment on "Scaling from individuals to ecosystems in an Earth System Model using a mathematically tractable model of height-structured competition for light" *by* E. S. Weng et al.

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This article presents full description of the new LM3-PPA model that integrates tree population processes in height-structured forest (PPA), physiological and allocation properties of trees, and biogeochemical processes of forest ecosystems. The key assumption of PPA is that the condition of foliage crown position of a tree in vertically structured forest patch is determined by its relative height in dynamic k layers divided by threshold heights (Z^*_k), and each layer (from the top layer-1 downwards) is determined by the sum of crown areas from the highest tree of the layer to cover the entire

area of forest patch. Under conditions that a forest has only one closed layer of top canopy ($k < 2$ with Z^*_1 height) and that physiological properties are in two states of either sun-exposed or shaded, previous PPA studies provide the analytical solution of tree height distribution of a single-species (or single-functional-type) population. As authors suggest and show insightful examples with simulation experiments, such simplicity of PPA is advantageous in functional understanding of ecosystem properties. I congratulate authors' success in coupling PPA and biogeochemical ecosystem model.

As is also pointed out by other reviewers, to show generality of PPA framework in global scale earth system modeling, it is better address the application to non-forest vegetation types. PPA of land-surface filling can also be applicable to short vegetation types of shrubland and grassland, as far as crown area is related to other functional dimensions of plants (either genets or ramets), such as crown-LAI, and allocation allometries. We therefore anticipate the extension of LM3-PPA with general parameterization for earth system modeling.

Meantime, there are a couple of limitations of PPA framework. For example, PPA does not describe spatial heterogeneity in gap dynamics as is briefly stated in Discussion. Authors suggest using patches (tiles) in varied states since disturbance (as well as in varied states of land use). Authors may rather explicitly suggest the alternative way of coupling patch-age approximation with PPA for dynamic landscape modeling.

Authors suggest $k < 2$ for most boreal and temperate forests, such as their example of temperate forests in north America, while maximum k can be 3 in tropical forests (Bohlman and Pacala). It is indeed an exciting question what determines k in forest ecology. Besides, at the scale of forest ecosystems, I wonder k in temperate forests usually have $k < 2$. In case of east Asian temperate forests, dwarf bamboo layer often entirely cover the understory ($k > 2$), and bamboos contribute to considerable proportion of biogeochemical processes. Another exception is non-continuous upper canopy layer in such ecosystems as tropical rain forests with emergent trees and tree savanna. These are to be improved in the next step (e.g. including shrub parameterization in

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PPA, and incorporating patch-age distribution into PPA).

A potential importance of dynamic vegetation models (DVMs) is to predict population transition with climate change under dispersal limitation and inhibition by resident-vegetation (e.g. TeeMig by Lischke et al.). As authors deal with recruitment/invasion processes in simulation experiments, it is worth comparing LM3-PPA with alternative simple height-structured tree-based ecosystem models that focus on transition prediction (e.g. TreeM-LPJ by Scherstjanoi et al. 2014).

It is an important suggestion that the optimal tree strategy under light and water competition does not bring about ecosystem-level maximum productivity, which is usually ignored in earth system simulators. I wonder there also be a miss-match between long-term genetic change towards tree optimal strategy and sort-term plastic responses to rapid climate change, which can also be addressed by the present model.

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