

## ***Interactive comment on “A stand-alone tree demography and landscape structure module for Earth system models: integration with global forest data” by V. Haverd et al.***

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**General Comments** This paper describes a new, and relatively simple, parameterization for treating forest stand dynamics for use within global carbon cycle models. The motivation for this work is in noting (1) the importance of representing woody turnover rate in carbon cycle models and (2) the poor apparent performance in global carbon cycle models in representing this turnover, owing the reliance on a first-order kinetic model of woody biomass loss. The key suspect in the poor performance in this regard is the absence of demographic models of tree growth and mortality - - where demographic mortality is the process that leads to transfer woody biomass from the living to

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the dead pool.

The authors have shown that it is possible to represent the process of allocating biomass increment among the different sized cohorts quite simply, using metabolic scaling theory. This biomass increment (framed as a relative growth rate) is directly used in the calculation of mortality by low resource availability and overcrowding.

The authors have shown that with one tuning step, the model is able to reproduce realistic patterns of size-number allometry and component biomass allometry, consistent with global databases of forest component biomass in the temperate and boreal regions. The authors have also shown that these patterns of size-number allometry are contingent on growth potential, which is the source of variation in the size-number allometry below its upper bound. This observation shows that it is essentially impossible to diagnose the number of trees from a stand-level biomass, which highlights the importance of implementing stand dynamics explicitly in carbon cycle models, as opposed to diagnosing the size of the mean individual and computing allocation based on this assumed size. The important distinction is the presence in a grid cell of a number of patches of different age, possessing cohorts of different size. Because these different cohorts face different mortality rates owing to asymmetric competition, the effective turnover rate is different from the diagnosed turnover rate for an “average” individual.

**Specific comments** I don't have strong criticisms of this work and I think it shows an elegant solution to a widespread problem. However, if I may there are a few comments that might improve this work

- in eqn 3 it is not clear if the exponent is in the denominator, or the entire fraction. Actually, it's not clear why this value needs an exponent on it at all, esp since  $p$  itself is an arbitrary parameter.
- GE is generally called the Relative Growth Rate or RGR.
- in Eqn 4, it would help to flesh out your logic for the reader, ie that individual growth

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(say  $G$ ) is allometrically related to individual mass to the  $3/4$  power, ie  $G \sim M^{0.85} \sim (C/N)^{0.75}$ . Thus  $G_y \cdot N_y$  is the growth fraction of the given cohort, relative to the growth fraction to all cohorts.

- in Eqn 5, the assumption that crown projected area follows a random overlap model is shaky - - you would need to have hugely large crown area to get complete ground cover in this model, but in reality if trees avoid each other,  $c$  can be close to  $A$ . That is, instead of  $C = (1 - \exp(-A))$ , why not try  $C = A$ ? I recognize that you parameterized this model initially in savannas, where there are legitimate ecological regions for trees to clump. But in temperate and boreal regions, this understanding is not correct, despite the fact that you are certain to find this assumption employed widely in the forest literature. I assume that the tuning exercise you employed compensates for this representation, and in the end doesn't profoundly affect your results. But I still think it should be corrected.

- this is outside the purview of this paper, but the use of fixed allocation fractions is questionable, although it too is a common assumption. There is another Wolf et al paper on this topic . . .

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