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Discussions

Interactive comment on "Predicting tree heights for biomass estimates in tropical forests" *by* Q. Molto et al.

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We thank the reviewer for the constructive comments. We generally agree with the asked modifications and provide further discussion where needed.

Some points were raised by the two reviewers. When necessary, the answer made to the other reviewer is duplicated here.

The authors have developed functions to predict tree height from dbh, stand structural variables and environmental variables for use in biomass equations for tropical species. They address three questions: 1) Which height model shape is most robust 2) Do model parameters vary between sites and, if so, what is impact on biomass predictions 3) Can the accuracy and precision of predictions be improved by including stand

structural variables and environmental variables. The data underpinning the analysis are from French Guiana, and include tree measurements in forest plots including dbh, stand data derived from dbh measurements, and environmental data. Species was known, but was not included in the analysis. Tree height was reported to be important for AGB estimation. In the absence of plot measurements, AGB was predicted with known precision (but accuracy not given?) using one (or more for that matter) of their height models. Stand variables were found to be important in explaining plot-to-plot differences, but environmental variables were not found to be important.

General comments R2Q1 This paper is narrowly focused on one region, but otherwise largely duplicates a previously published paper on tropical forest height prediction by Feldpausch et al 2011 (work cited in this paper). Nevertheless, this paper would be useful if the authors use the French Guiana study to test the Feldpausch et al model, as a basis for validating and improving their own height prediction methodology. The outcome may be that no improvement in height models is required, or alternatively, the development of functions that do not include species (which is acknowledged to be important determinant of height by these authors and Feldpausch) may be found to be fundamentally flawed when applied to specific regions.

R2A1 Sadly, it appears that the given information in Feldpaush et al. 2011 in the section "working equations" is not sufficient to apply their model since they do not supply the error terms. The errors terms are required to convert log(H) to H because the base e exponential of a normal distribution does not mean to 0. In addition, our conservative attitude considering uncertainty propagation makes that we need the error terms to compare the model outcomes. Thus, were not able to apply their equations to our data. We agree that some of our work duplicates questions addressed byFeldpaush et al. 2011. However, our hierarchical modeling methods and the way we compared modelsare radically different: First, they had trouble fitting the models they wanted to test ("The greatest constraint on non-linear models was that they frequently did not converge (e.g., 30% of the time for the Weibull function for plot-level fits)"). We show

that with convenient weighting and fitting methods, this is not a constraint. Second, they add the environmental information in their model as an additive effect: log(H) = f(log(dbh)) + error becomes log(H) = f(log(dbh)) + environment + error Using multilevel modeling techniques described by (Snijders and Bosker,1999). We prefer to apply the environment effect on the H-dbh model parameters themselves. In other words, the model parameters are function of environmental and structure variables. It seems more logical to us that the environment can directly affect the model parameters, e.g. such as the maximum height. Overall, we do not think to our work as an "improvement in height models" but as an improvement in the way of handling the height model question. Of course our results in French Guiana are not as general as the results found worldwide by Feldpausch et al. 2011 but we still think that our modeling approach is worth reading by height-dbh modelers.

R2Q2 The paper presents predictions of above ground biomass, based on the alternative height models they developed (Figure 2). The mean and error of above ground biomass predictions should be extended to include estimates based on actual height measurements.

R2A2 There should be some misunderstanding from the reviewer because this is exactly what is done here on Figure 2. We use RMSE (Root Mean Square Error) to depict the difference between biomass predictions based on actual height and biomass predictions based on predicted heights. Maybe our method description (line 11-13, page 8619) is not clear enough. We will rephrase it using "based on actual heights" instead of "obtained from measured height". See also paragraph R2A8 of this discussion.

R2Q3 If species is important (as acknowledged) what would the improvement be if species was included in their height models. There would need to be background provided in the Introduction to signal what requirements would need to be met to allow species (species appears to have been recorded for these 42 plots) to be included in their analysis of height models. It is currently not possible to tell how many tree height measurements are available per species and by plot and how well they cover the dbh

range. If species can not be included in their height models (owing to data limitations), is the approach adopted (using stand and environmental variables) sufficiently robust to be useful. This is where comparisons with Feldpausch et al 2011 will be helpful. Have the new models improved predictions for this region, or are existing models sufficiently accurate.

R2A3 We did not include the species effect in the model as we wanted to keep it operational for large forest inventories with no species identification available. See also our response paragraph R1A2 to the reviewer #1: "R1A2 The plots are described in a table in the appendix. We could add a short paragraph to summarize this table. The plots are also extensively described in Baraloto 2011, but we could repeat some short information on the species composition. Like the reviewer, we think that community species composition (eventually through the trait composition) may have a strong effect on the height-DBH relationships. Because our recorded datasets are very complete, we could have addressed this interesting ecological question. But we believe that this is beyond the specific scope of this paper and we will keep it in mind for future work. Our specific goal is to provide and methods for height predictions that are to be applied to various forest inventories. These inventories include large and/or old inventories that lack detailed information such as species identifications or functional trait values, but they may be considered as important source of information for carbon stock assessments. Therefore we kept the model as simple as possible and did not use the species identifications."

R2Q4 The application of height models that include species may not be feasible at this stage in tropical forest inventories, owing to the diversity of species and practical issues) however, the improvement in accuracy of AGB predictions can not be assessed without comparing predictions with estimates based on actual height measurements. The latter Discussion Paper should be used to test the validity of Feldpausch et al 2011 models, both on a plot specific basis and over all plots.

R2A4: see our answer on why we did not compared our models with Felpausch et al

2011 (R2A1). Since it appears to be a major concern, we could develop this point in the manuscript itself. Specific comments

R2Q5 A better title of a suitably revised manuscript would be- "Test of height predictions functions for biomass estimation of tropical forest in French Guiana".

R2A5 This was also suggested by reviewer #1. Maybe the editor could make a choice on this point.

R2Q6 Height measurement can be difficult in tropical forest. Was height to the top of the tree crown measured? Were height trees leaning (lean may not be an issue in tropical forests?), and if so, how was lean dealt with? Was dbh range covered adequately for each species? How were species with buttressing treated? It may be that validation will need to be restricted to a subset of the species.

R2A6 The tree heights were measured from ground to the top of the crown. When a buttress was present, the dbh was measured above buttress. These practices are usual good practices in tropical forestry.

R2Q7 The discussion around forest succession, and competition (stage of development) effects on height model parameter seems speculative. Will these arguments apply if species effects are included in height models? Will the well documented impacts of environmental variables become apparent after species effects are included in height models?

R2A7 We agree with the reviewer. We could rephrase the part concerning the stage of development to make it sound more like a possible explanation and make it clearer that there are differences in species composition. The opposition we found between dense small trees and rare big trees remains true anyway. If they are both different species and different environment condition, there is no way to decouple the two effects... And the fact that taking in account the gradient of environmental variables makes the Height-DBH model more accurate is the main point here. We could emphasize on this instead

of speculating on ecological reasons for this.

R2Q8 The methods state that AGB of the trees was obtained using 1 -measured heights, and 2 - predicted heights. Where are estimates based on measured heights given?

R2A8 The AGB estimates based on measured heights are given in the appendix, along with the description of the forest plots. However, the goal of the paper is not to give AGB values but to compare AGB predictions based on actual heights and AGB predictions based on predicted heights. This comparison is performed through RMSE calculations. We do not think that absolute AGB has a great importance here.

R2Q9 In conclusion, the paper has a lot of potential to be of high interest, but not in its current form.The authors should ensure that their final paper is professionally editted before being submitted.

R2A9 Ok, this was also coined by the other reviewer.