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Interactive comment on "Canopy Area of Large Trees Explains Aboveground Biomass Variations across Nine Neotropical Forest Landscapes" *by* Victoria Meyer et al.

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Thank you for taking the time to review our paper. We did our best to address all your comments in the hope this will improve the quality of the manuscript. Please note that all references to changes in manuscript correspond to the line numbers of the revised manuscript with track changes.

Comment: For this method to be useful, it must either (1) outperform existing methods, (2) perform similarly to existing methods but at lower computational cost or (3) open up new applications not allowed by existing methods.

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Response : Our study does open up new applications compared with existing methods. We demonstrate that our method performs similarly to another method relying on information from all trees within a plot (MCH). The point of our paper is not to say that the LCA method is better than the MCH method, but rather to show that information on large trees is enough to estimate biomass. Our findings confirm what has been shown in several studies focusing on ground data (Bastin et al, Slik et al. . .) and shows for the first time that relying on large trees from a remote sensing perspective allows to estimate AGB. It opens up new applications both for field inventory and remote sensing applications. In the discussion (section 4.8), we talk about how methods focusing on large trees could help future space missions, such as BIOMASS and GEDI, to accurately estimate biomass and open up new applications. LCA also gives information on the presence of large trees in a study area, which other metrics such as MCH cannot do. It is an important point, considering that large trees are often the most affected by natural disturbance and targeted by logging companies. Changes to manuscript: ls.455-457: "LCA provides information on the presence of large trees in a study area, which other metrics such as MCH cannot do. It is an important point, considering that large trees are often the most affected by natural disturbance and targeted by logging companies." ls.564-565: "The comparison of LCA and MCH metrics showed that both performed similarly in estimating AGB, highlighting the importance of large canopy trees to estimate biomass." ls.645-647: "The results of our study may encourage further research in the use of Lidar data for detecting the distribution of larger trees in tropical forests for ecological and conservation studies."

Comment: The paper is framed around comparing the new LCA method against the existing MCH method, but a clear comparison of the two against ground-based validation data is not presented.

Response: Thank you for pointing this out. We added a short paragraph in the method section, as well as a new section in the Results and in the Discussion, comparing the performance of LCA and MCH methods. This is presented in the Methods (ls.218-240),

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in the Results (ls. 345-379) and in the Discussion (ls.563-569). To avoid any confusion, we moved the MCH local estimations of AGB from the main Lidar data paragraph to the Supplementary information (S.2). AGBLidar was also renamed LCALocal for clarity. Changes to manuscript: see ls. 218-240, ls. 345-379 and ls. 563-569. Figure 5 (attached here as Fig. 1) We chose to keep Table S3 in the Supplementary Information for clarity, but we added a figure comparing AGB estimations using the 2 methods (Figure 5, attached here as Fig.1).

Comment: Is LCA quicker to calculate than MCH? It would be useful to present a comparison of the computational time taken to calculate LCA versus MCH.

Response: LCA is not quicker to calculate than MCH, but it is not significantly slower either (below 1s for both methods). Also, the strength of LCA lies in the structural information it provides, not in its computational time. Thus, we chose not to add a detailed comparison of computational time.

Comment: The application to detect the impacts of selective logging is potentially very important.

Response: We agree. We emphasized this point in the Discussion: Changes to manuscript: ls.609-611: "LCA could become an important tool to detect forest degradation, in particular selective logging, considering that large trees are targeted by logging companies."

Comment: My main suggestion to improve this paper are to concentrate on testing the relative performance of LCA and MCH approaches at estimating biomass when validated against inventory data (even if LCA performs worse, this is still a very useful result for method development),

Response: Thank you for your suggestion. As mentioned above, we added a paragraph in the method section, as well as two new sections (results and discussion) and a figure comparing the two methods, showing that they perform very similarly. We also

show how they differ in terms of AGB estimations in different sites.

Comment: and comparing the performance of the two approaches when applied to detect the impacts of selective logging.

Response: We compared the performance of the 2 approaches when applied to selective logging detection. The MCH model showed a loss of biomass of 19 Mg ha-1, compared to 15 with LCA and 9 from a previous study based on rh25. We added this information in the results and the discussion. Changes to manuscript: ls.393-394: "As a comparison, the MCH model led to an estimated biomass loss of 19 Mg ha-1." ls.607-609: "The higher biomass loss estimation from the MCH model (19 Mg ha-1) again shows how different metrics can lead to different results. Here, three methods based on three different Lidar metrics yielded results that differed by more than twofold.".

Comment: I agree with reviewer 1 in that I don't see much value in testing the performance of LCA against biomass estimates using MCH.

Response: Thank you for your suggestion. We removed Figure 5b. Performance comparison of LCA and MCH model at the calibration sites is now based on Figure 5a. The models applied to the nine sites are now Figure 5b, following your other suggestion to focus on the comparison of LCA and MCH methods.

Specific comments:

Comment: Line 205 – How was bias calculated?

Response: We added the definition of bias to the manuscript: Changes to manuscript: ls.214-215: "bias (mean difference between the expected values of AGB and the observed values of AGB)".

Comment: Line 262 – What are the other models apart from a power law fit?

Response: For both LCA and MCH models, we tested linear models and power laws, which are the 2 common fits. We modified the sentence to avoid any confusion:

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Changes to manuscript: ls.302-303: “with a better coefficient of correlation and RMSE than a power law fit”

Comment: Line 262 – 263 – Are RMSE values and r squared values here from cross-validation or from the training data? Line 263 – Just present the bias from cross-validation.

Response: R2 and RMSE are from training data. We removed the bias from the training data and present the bias from cross-validation. Changes to manuscript: l.304: “biascross_val = 0.16 Mg” ls.334-336: “coefficients of correlation, RMSE and bias from training data and cross-validation are reported in Table 3.”

Comment: Line 271 – How feasible is it to scale by wood density in the absence of inventory data? Presumably errors would be larger if modelled estimates of wood density were used.

Response: We agree. If there is no information in the literature from previous studies, modelled WD could be used, but would indeed give greater errors. This is now covered in the Discussion. Changes to manuscript: ls.558-561: “In the absence of information on wood density from the literature, modelled wood density could potentially be used, but would give greater errors. These errors should be taken into account when reporting on the uncertainty of the results.”

Comment: Lines 287-301 – It would be useful to also see how MCH performs at detecting this loss of biomass.

Response: The MCH model (Table S3) gives a biomass loss of 19mg/ha, more than twice what was reported in Andersen et al., 2014. These results were added to the results section and the discussion section 4.6.: Changes to manuscript: ls.393-394: “As a comparison, the MCH model led to an estimated biomass loss of 19 Mg ha-1.” ls.607-609: “The higher biomass loss estimation from the MCH model (19 Mg ha-1) again shows how different metrics can lead to different results. Here, three meth-

ods based on three different Lidar metrics yielded results that differed by more than twofold.".

Comment: Lines 376-377 – This is a very nice approach to identify how much biomass is missed by LCA.

Response: Thank you for this positive comment.

Comment: Figure S2 - Given that the minimum cluster size didn't have a major effect on the AGB estimates, I would be interested in seeing a comparison of the performance of the LCA metric just following masking versus the LCA metric following removal of segments below the threshold cluster size. How computationally costly are these last steps?

Response: This is a good point. For a reference image of 1000x1000m pixels, the full process takes less than one second. Just using masking may be slightly faster, but the computational cost is not an issue here. Just using masking gives similar results as when using LCA, because the pixels removed by the full process represent a small fraction of the area covered by large trees (1.73% on average). (R2=0.78, RMSE=45.7, bias=0.55) These isolated pixels either represent single branches reaching above 27m or the tip of a tree whose crown is mainly below 27m. Therefore, these pixels have no meaning in terms of our LCA metric and do not represent large trees. This is why we chose to remove them. The goal of our study is to show that large trees are sufficient to estimate AGB. We clarified this point in the manuscript: Changes to manuscript: ls.450-454: "Clusters smaller than 100 m2 add only a small fraction (1.7% on average) to LCA values across sites. Including these clusters in LCA would not impact the performance of the model (similar R2, RMSE and bias) and would allow to skip the final steps of the LCA retrieval (see Fig. S2). However, since these pixels either represent single branches reaching above 27m or the tip of a tree crown, they have no meaning in terms of our LCA metric and do not represent large trees.".

Comment: Technical comments: Inconsistent approach to using capitals in section

headings. Line 209 – => Detecting changes of selective logging. Line 385 - => LCA as an AGB estimator

Response: Thank you for pointing this out. We removed the capital letters accordingly.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-547/bg-2017-547-AC2-supplement.pdf

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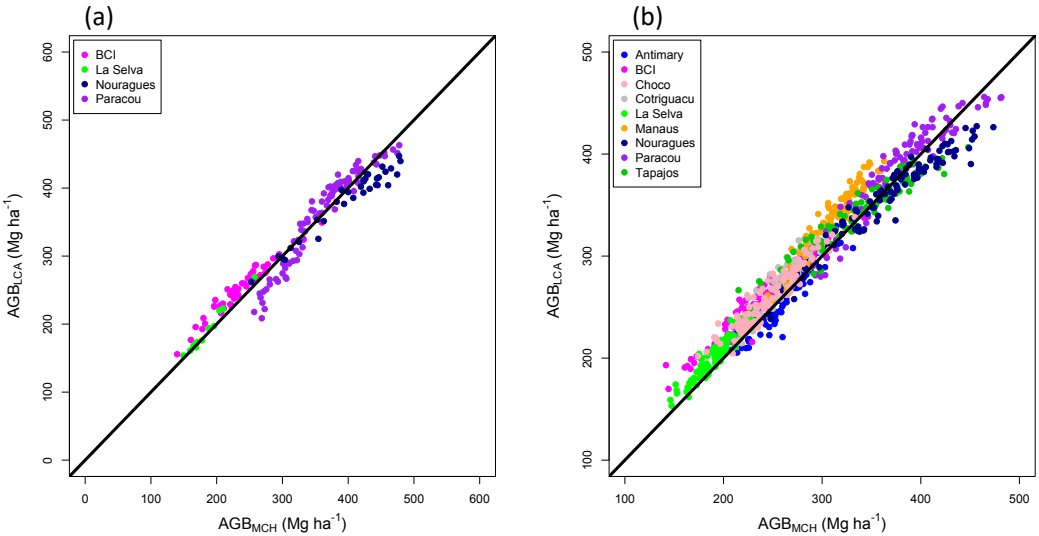

Fig. 1. AGBMCH vs. AGBLCA in the plots of the four calibration sites (a), and AGBMCH vs. AGBLCA in the 1km2 images of the nine sites (b). The black line represents the 1-to-1 line.

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