Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-277-RC1, 2019

Biogeosciences Discussions

Interactive comment on "An analysis of forest biomass sampling strategies across scales" *by* Jessica Hetzer et al.

Anonymous Referee #1

Received and published: 11 September 2019

The paper by Hetzer et al. aims at assessing the effect of sampling strategy for estimating tropical forest aboveground biomass at different spatial scales. While this topic is of importance, it has already been well covered in the litterature. However, the simulated approach developped here have some originality (e.g. the point pattern reconstruction) but, in my opinion, some rather surprising or context-dependent results are due to methodological artefacts as described below. These artefacts are rather difficult to overcome but they should be at the minimum discussed or acknowledged before consideration for publication.

##Major comments

Globally, many statements (see my specific comments) are very basic and already well known in the litterature (e.g. many sentences in the conclusion section). The author

should refer more to previous works and concepts, including those developped for temperate forests where a huge research effort on sampling strategy has been done in the past.

Investigating the effect of spatial scales (local, regional and continental) on sampling strategy is very appealing. However, I am very skeptikal about the use of remote sensing products as reference data. Both Asner and Baccini used passive optical data to extrapolate AGB at large scale and these products are well known to saturate for large AGB (>100-200 t/ha) values leading to a strong underestimation of AGB variability. This effect is well illustrated by the Fig. S2 where the SD of AGB first increase with AGB and then decrease. Theoretically the SD of AGB should continuously increase with the mean AGB (this is why people generally use CV instead of SD for comparison purpose). Thus, the decrease of SD with AGB in Fig. S2 is simply an illustration of the saturation problem so that using these maps, or dowscaling them using such SD pattern, result in a strong underestimation of AGB variation in high biomass areas, which, in my opinion, bring a strong bias in the final results presented here. This is probably the reason why some results are very counter-intuitive, such that plot size does not matter at large scale or that a large number of large plots provide less accurate AGB estimate than a small number of small plots (Lines 157-159).

I had two problems with the simulation of RS sampling. First, RS was simulated as discrete measurements, may be to simulate satellite LiDAR measurements such as those produced by GLASS or GEDI, but there is no justification for that (most satellites produce continuous measurements). This is surprising given that the authors used continuous RS-based maps to validate such RS sampling strategy, which look like a bit skizophrenic. Second, I did not fully understand the methodology. I understood that measurements were simulated at different distance along simulated transects but I did not understand how and if the distance between transects varied or not. I am not even sure that the authors simultaneously simulated several transects as would typically be done by a satelitte. I would suggest to simulate a sampling design similar to the one

that was or is adopted by GLASS or GEDI to make this simulation more practical even if this is challenging due to the high resolution of LiDAR footprint (∼70 and 20 m) and the abovementioned downscaling problem.

The sampling showed in Fig. 2 illustrates a major problem. Nobody sample at the same time dense humid and dry forests to depict a mean biomass. This is always practically done by forest type using a prior stratification design. The minimum, to have something comparable with the other scales (BCI and Panama) is to focus only on tropical dense humid forests. This may explain why an aggregated sampling design produce such huge errors given that it sample very different forests at the continental scale.

As illustrated in Fig. S3, and by previous studies conducted in BCI, the spatial distribution in AGB do not significantly differs from a random distribution. This explain why, for a given sampled area, using several small or few large plots little impacts your estimates. This should be better explained in the present paper by explicitely mentioning the effect of spatial aggregation on sampling design and by stating that your result would probably not hold at the same scale in many (!) other forests that show strong AGB aggregation patterns (which is the case of most forests). Note also that the central limit theorem only applies if observations are independents (i.e., in absence of significant spatial structure), such that this theorem is theoretically valid only for the BCI scale in your study.

The discussion section may discuss the realism of a random sampling design at the continental scale in Amazonia.

The conclusion section should highlight more the originality of the present work.

##Specific comments

Line 27: space lacking: “important(Broich”

Line 29: Are those referenced all provided biomass maps?

Line 34: Please replace by “so that the local distribution in biomass”. At least remove

“local regions”, which is inapropriate.

Lines 34-35: This last sentence is very vague.

Line 45: This is an old reference, what about most recent works such as Baccini and Saatchi maps?

Line 49: Assume that plots or biomass are. . ..

Line 52: I don’t see the logic here. First it is obvious that the representativness of a given number of plots is context-dependent and varies with the total area of interest and second the number of plots fall into the recommendation cited line 48 so that it does not illustrate that the number of plots varies according to the sampling design.

Figure 1: I would have personally not call the b panel a landscape scale but rather a regional scale. I know that the definition of scale strongly varies in the litterature but I can hardly imagine a landscape of more than 500 km.

Line 73: “determined using allometric relationship” is really vague, unless the methodology is fully described in the Knapp paper. If yes, please add (see Knapp. . .. For details).

Lines 77-78: The following sentence is useless and confusing (strange to refer to plots for RS maps, we usually use pixels instead): “For this purpose, between 4 and 25 plots from the original map were averaged.”

Lines 79-80: This last sentence is useless.

Line 81-82: This is not true that the Baccini map mostly derived from LiDAR measurements. The global methodology used was to callibrate GLASS LiDAR footprints with field data and then to calibrate a MODIS product with the calibrated LiDAR measurements. Thus the final product mostly reflect MODIS data, that are very little sensitive to biomass and highly sensitive to cloud cover (e.g. the large area of lower biomass observed on the western coastal area of central Africa, compared to the central basin,

is simply due to cloud cover).

Line 83: Please provide rounded numbers.

Line 86-87: Please replace plot by pixel.

Fig. 3 legend: “below the bar ” should be replaced by “above the bar”

Lines 143-144: Very obvious and well-known result.

Lines 154-155: First sentence useless.

Lines 180-181: Please reformulate.

Lines 230-232: Very obvious.

Line 235: If forest types are known a better strategy would be to stratify the sampling by forest types.

Lines 255-256: As already shown and discussed by previous works.

Line 259: What is a regional scale here?

Line 267: For a given sampled area, plot size should not. . ...

Line 270-271: This is what is generally done, remote sensing almost always relies on field data. Please be more explicit.

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