

## ***Interactive comment on “Structural effects of liana presence in secondary tropical dry forests using ground LiDAR” by A. Sánchez-Azofeifa et al.***

### **Anonymous Referee #2**

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#### General comments:

The authors have undertaken an interesting study of the structural effects of lianas in tropical dry forests and the extent to which structural changes may be detected using ground based lidar at different stages of forest succession. Furthering our understanding of the role of lianas in forest successional processes is of great merit in terms of forest management in general and carbon accounting in particular. The use of ground based lidar (terrestrial laser scanning, TLS), as a structural measurement tool is reasonable in the context of the study.

There are some aspects of the study which need to be improved to make the manuscript suitable for publication. These can be divided into two main categories:

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1. Description of the lidar metric ‘Radius of Gyration’ (RG) as a means of describing forest structure. The authors have given a conceptual description, but I still have trouble understanding what it means, ecologically or structurally. For example, what would an ‘increase in RG’ look like in the forest? On page 17165, line 5: “. . . Stands without lianas showed a significant gradual increase in the RG. This is consistent with accumulation of basal area, vegetation material and biomass accumulation. . .”. How does an increase in RG relate to an increase in basal area? Some further descriptive words or illustrative (even simulated) examples of PAVD profiles with different RG values would help greatly.

2. Field plot selection and description. This is perhaps the biggest issue. A total of fifteen plots were sampled across three different forest successional stages: early, intermediate and late. Of these, 9 sites had lianas and 6 did not. A detailed description of these plots is critical as the basis for subsequent analyses. Specifically:

a. Describe the inherent between-plot variance within succession classes without lianas. It is difficult to know whether statistically significant differences in PAI, PAVD or RG metrics could be observed between plots within the same succession class without lianas. This then makes it difficult to judge the significance of differences between plots with- and without-lianas.

b. What is relative location of the plots? It is interesting to note in Figure 2 that the intermediate-aged plots with lianas are approximately 4 metres taller than the intermediate plots without lianas. Is this caused by lianas or geographical differences related to climate, topography or soil. A map illustrating the plot locations would be useful.

c. In what way might the classification of age classes predetermine the observed differences in PAI, PAVD or RG metrics? Page 17158, line 15 mentions that the “. . . number of vertical strata” was one of the criteria used to differentiate age classes, a priori.

d. How does liana density vary between plots? Is there any way to quantify this in terms of stems-per-hectare of lianas or liana-affected trees within the plots? On page 17165, the last paragraph discusses the general lower density of lianas in late, compared to

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intermediate, successional stages. This naturally raises the question “how does liana density vary within and between age classes in the sampled plots”?

Detailed comments:

p. 17154, line 18: “. . .distinction of vertical strata and the vertical height of accumulated PAVD”. Suggest changing this to “distinction of vertical strata and canopy height”.

p. 17155, line 11: change “old growth forests” to “old growth tropical forests”.

p. 17156, last para.: “Ground LiDAR has demonstrated the capability to measure canopy properties such as height and cover (Ramírez et al., 2013) and tree architecture (Lefsky et al., 2008), using terrestrial laser scanning systems (TLS). . .”. Suggest removing “. . .using terrestrial laser scanning systems (TLS)” as this is synonymous with ground lidar in the context of this study.

p. 17157, line 2: “. . .Laser 65 Scanners. . .”. Check.

p. 17157, line 3: “. . .pulses emitted in the visible or near-infrared comes into contact with an object, part of that energy is reflected back toward the instrument. . .”. Technically, other wavelengths are reflected too. Lidar systems operating in the short-wave infrared and even ultra-violet are common. Perhaps remove or qualify the wavelength specificity.

p. 17157, line 23: “Significant increases in vertical structure with stand age (e.g., as a result of increases in basal area, height and volume with stand age). . .”. Despite the examples, I am still confused by the terminology “increase in vertical structure”. Do you mean “structural complexity”?

p. 17161, line 9: “we used the RG to relate the shape of the PAVD profile to forest biomass at the footprint level (3600 m<sup>2</sup> or 0.36 ha)”. At the fixed scan zenith angle of 57.5 degrees the plot area is defined by the mean canopy height, as this dictates the horizontal distance from the instrument when the laser exits the canopy. If the trees were all exactly the same height (h), the laser would exit the canopy at a distance of (h

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\*  $\tan(57.5 \text{ degrees})$ ), or approximately 1.6h from the plot center. At  $h = 33 \text{ m}$  the laser has reached its maximum effective range of 60 m as defined on page 17160, line 17. Based on the PAVD profiles in Figure 2, the minimum and maximum canopy heights are approximately 10 m and 18 m, respectively. This translates to plot areas of 0.08ha to 0.26ha.

p. 17162, line 9: “A change or no significant increase in PAI as a function of RG during succession would suggest that lianas may be altering the successional trajectories. . .”. This is somewhat confusing. A change in what way?

p. 17162, line 14: “. . .the radius of gyration (RG) showed a significant increase along in succession in plots with no lianas (Table 1). . .”. First, consider removing the words “along in succession”. Secondly, the RG metric increases in plots with no lianas in the late successional stage plots only. In the intermediate age class the reverse seems to be true. Please clarify.

P. 17163, lines 14 & 15: Should the text refer to Figure 2?

p. 17166, line 12: The “vertical height of PAVD” is better described simply as “canopy height”.

p. 17174: The Figure 2 caption refers to a “Time-series” of PAVD, yet there is no timescale or differentiation of scan dates in the figure. Suggest removing the “time-series” terminology and simply state “Figure 2. Plant Area Volume Density (PAVD) values calculated by. . .”

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