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Hydrology and Earth System Sciences Discussions

Interactive comment on "Estimation of forest structure metrics relevant to hydrologic modeling using coordinate transformation of airborne laser scanning data" *by* A. Varhola et al.

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Reviewer #3 – Anonymous

We greatly appreciate the reviewer's careful attention to our study and positive feedback. The few concerns identified are addressed below.

GENERAL COMMENTS

1) "Although not the goal (as the authors mentioned), I think the method could be easily applied to other types of forest and LiDAR data sets, as I see no special requirements

of the method in this context that would suggest otherwise. Especially the application of full-waveform data (FWF) would open up new prospects for the approach. It would benefit from the generally higher amount of returns in vegetation and from the additional radiometric and geometric properties that can be derived from FWF (i.e. width of backscattered echo and backscatter cross section). The backscatter cross section could also be another solution for one of the approach's drawbacks: the more or less arbitrary size of the projected LiDAR echo. Wagner et al. (2006, 2008) describe the backscatter cross section as the effective area of collision of an object and the laser beam. Having FWF data at hand, this measure could be calculated and used for deriving the size of the echoes." REPLY: We fully agree with the reviewer, so this sentence has been added in the fourth paragraph of section 4.3 (Modeling strategy): "Of particular interest is the application of this method to full-waveform (FW) LiDAR data, which will be increasingly used in the future and provides a more detailed profile of canopy elements and additional radiometric information (Pirotti, 2011). FW LiDAR also has the potential to assist in a better estimation of the return dimensions by the analysis of target backscatter cross sections (Wagner et al., 2006, 2008). However, given that discrete ALS has been used extensively in many regions, our methodology is not likely to become obsolete in the near future."

SPECIFIC COMMENTS

2) "Another drawback I see lies in the differing viewing geometries of airborne LiDAR and HP. The authors mention this difference in the manuscript as an error source. I actually think that low to medium density LiDAR point clouds (as used in the study) do not offer enough detail to represent sub-canopy architecture (i.e. leaves and branches) directly, but more a rough abstraction of them (regardless of discrete or full-waveform LiDAR). For features like leaves and branches, I think one would need really high density LiDAR point clouds (e.g. >250 echoes / m2, possibly from UAVs) or use terrestrial laser scanning data, as mentioned by the authors. This is critical because HP gives exactly that: a representation of sub-canopy strata." REPLY: We have stated on P5547-

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L3-6 and P5550-L21-22 that the low density of our dataset makes it difficult to identify individual trees in the synthetic images. The more detailed canopy representations potentially provided by higher density datasets is discussed on P5551-L2-7, and a statement of how that the methodology needs to be tested in acquisitions of different return densities is on P5553-L25. We agree with the reviewer's point related to higher density datasets producing better outcomes, but we have proven that low-medium density datasets were able to provide good estimates of gap fraction, LAI and SVF.

3) "5540.L3: even though the reader gets the meaning, the formulation 'one dimensional laser point' sounds odd to me. Maybe this can be rephrased." REPLY: "one dimensional" removed.

4) "5541.L1-10: a long description on the optical distortions of hemispherical lenses is given, only to conclude with one sentence that circular representations for the LiDAR 'spheres' are used because it is easier to plot them. So the description can be shortened." REPLY: Please note that the procedure explained in that paragraph is still important because we have only simplified the projection of returns as spheres rather than ellipses, but their area has been indeed modified to reflect the distortion. We wish to maintain the explanation provided to be as clear as possible, but to help the reader understand the procedure we have created a new figure (Fig. 3b) that illustrates it. Also, the importance of this distortion correction has been added as suggested by Reviewer 1 – Dr. Konrad Schindler (please see comment #15).

5) "p. 5543.L9: 'LD' in my opinion is related to both: structure and acquisition conditions (e.g. dense canopy architecture will influence LD)." REPLY: We have added the word "mainly" to the sentence to imply that LD can also be affected by canopy conditions but it is still mainly a sensor attribute.

6) "p. 5543.L26: I think that vegetation echoes at small angles of incidence are also less likely because the footprint is bigger, thus the available energy for every scattering element is less and therefore often not enough to trigger a return pulse in the detector.

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I cannot really follow the argument with the longer path length." REPLY: We have reworded the phrase, which now reads: "For example, if scan angles are too large, laser pulses are less likely to penetrate the canopy because of a higher probability of being intercepted by stems, resulting in a different spatial representation of the forest. . ."

7) "p. 5554.L12: the authors state that their method avoids the need for a separation of LiDAR points into ground and non-ground classes. This is not a generally difficult task, as a DTM is usually at hand. And in the paper a separation in 'canopy' and 'sub-canopy' echoes is carried out, which is essentially the same." REPLY: We have removed the sentence about ground and non-ground separation.

8) "p. 5540.L18: ...the diameter of each projected..." REPLY: Corrected.

9) "p. 5551.L2: ...needs to BE sufficient..." REPLY: Corrected.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 5531, 2012.

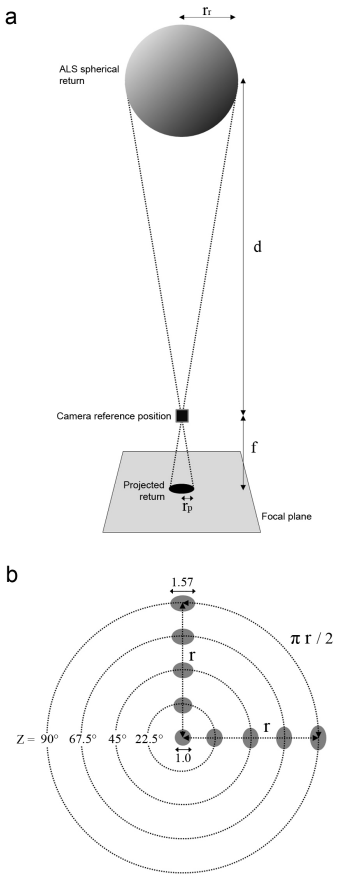

Fig. 1.

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Interactive Comment

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