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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 #4 – Anonymous

We greatly appreciate the reviewer's careful attention to our study and feedback. The reviewer explains that an approach that accounts for 3-D information provided by ALS is a better way of obtaining forest structure information, but remains supportive of our study. His comments are replied as follows:

GENERAL COMMENTS

1) “My main response is that transforming ALS data coordinates to mimic hemispherical photographs is the wrong way to go. In my opinion, a much better way to make use of the ALS data would be to adapt the hydrologic models to use three-dimensional vegetation structure information. I would suggest developing methods for three-dimensional analysis of the ALS data and adapting the hydrologic models for this input. From my understanding, hemispherical photographs are used because they have been the only feasible way to obtain information about vegetation structure. However, the information obtained from hemispherical photographs is two-dimensional (coverage projected along polar axes) and does not fully describe the three-dimensional structure.” REPLY: We disagree that mimicking hemispherical photographs is “wrong” because even though they transform 3D data into 2D, they provide valuable information about forest structure and sub-canopy radiation regimes. Even if 3D information is directly used, we would still need to summarize complex spatial attributes into bulk metrics representative of a spatial unit, especially if this information is needed by hydrologic models. We agree that there is a vast number of approaches that can be undertaken to take advantage of a more direct use of ALS data, but this is beyond our scope. All the advantages and limitations of our procedure and ideas for future work have been explained in the manuscript, but an additional explanation justifying the use of hemispherical photography and GLA has been included in the first paragraph of section 4.4 (Methodological advantages and applicability).

2) “A better description of the three-dimensional structure would be possible from ground based laser scanning. Airborne laser scanning does not measure all surfaces in the understory below the dominant tree layer, which means that it contains less information than ground-based laser scanning. However, the transformation described in this paper does not improve this. The transformation actually reduces the amount of information in the laser scanning data. Three-dimensional analysis of laser scanning data should be able to provide three-dimensional vegetation structure that can be used as input to adapted hydrologic models.” REPLY: The level of detail representing canopy structure required by a study of hydrologic processes depends on the spatial scale, so

TLS cannot be judged as “better” than ALS because the latter can cover extensive areas and more easily parameterize fully-distributed hydrologic models. To our opinion, the ultimate goal is to use remote sensing to better characterize forest structure at the watershed level, and ALS seems to have unparalleled capabilities of achieving this. On the other hand, we understand and agree with what the reviewer is pointing out: that we need to directly use metrics obtained from LiDAR in favour of hydrologic models. However, the right approach to fulfill this involves developing new physically-based equations to model radiation regimes, interception/evaporation/sublimation, water dynamics in the canopies, etc., based on LiDAR metrics. Please see reply to comment #7 of Reviewer #1, in which we address this issue.

DETAILED COMMENTS

3) “Page 5538 line 5: Why did you not measure the GPS position of the point where you took the hemispherical photographs? The positioning error could cause problems due to local variations in vegetation structure.” REPLY: When the original optical photos were taken on 2008, writing this specific article was not in our plans. We have added this explanation on the first paragraph of section 2.2 (Data acquisition for modeling).

4) “Page 5538 line 22: What was the pixel size of the DEM? If the area of each pixel was 5 m2, the pixel side was approximately 2.2 m which is rather big.” REPLY: The actual DEM resolution is 25 m2 (now corrected), from a 5 x 5 m pixel. This seems big but is not relevant because all the ground plots are flat.

5) “Page 5538 line 25: A plot size of 50 x 50 m is very big; I would suggest using smaller sub-plots and calculating averages and variation for the sub-plots within one plot to better describe the vegetation structure, or working with representations of individual tree crowns.” REPLY: The variability of ALS metrics in smaller plots (12.5 and 25 m cylinders at each sampling point) was actually checked and confirmed negligible. This is because the plots were properly located to represent relatively homogeneous canopy conditions (Teti, 2008).

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Interactive Comment

6) “Page 5539 line 4: The single highest ALS return is likely to be an outlier, which is not representative of the whole plot. I would suggest using for example the 95th or 99th percentile.” REPLY: we agree, but we confirmed that maximum canopy heights obtained in such a way were not outliers. Also, this metric was not used in the final models so it remains irrelevant.

7) “Page 5539 line 14: How does 234 relate to the total number of sampling points? If I understand correctly, the total number of sampling points was 7 x 36 = 252. Is that true and how many did you exclude?” REPLY: this is explained on P5539-L12-14. One plot was too close to the boundary so three rows were discarded (252 – 18 = 234).

8) “Page 5539 line 19: Why did you collect the ALS data in the winter? The varying snow depth causes an uncertainty in the ALS data.” REPLY: The data was not collected for other studies related to hydrologic research, and was collected in winter because we needed the snow in the background in the high-resolution aerial photographs taken simultaneously with the LiDAR. We do not expect the shallow snowpack in the ground to be a source of significant error (not registering the camera position is possibly much higher) and its depth was indeed accounted for (P5539-L17-20).

9) “Page 5544-5545: The chapter Regression modeling contains several steps and to me it is unclear if, for example, page 5544 line 22-25 were done before equations 1-2 were fitted or at the same time as page 5545 line 19-25. The chapter could be made more clear by dividing it into bullet points or similar.” REPLY: The section is written in chronological order of steps, but since we used a semi-manual approach for variable selection and hence loop with trying different variables, it is challenging to create a bullet point list. However, we have clarified that the correlations were examined before fitting the models to satisfy the reviewer’s concern.

10) “Page 5545 line 5: What you call split-sampling average seems to be the same as leave-one-out cross-validation, which is a more well-known statistical term.” REPLY: Changed.

11) “Page 5547 line 5: You indicate that a point density of 5-8 m-2 is too low to identify individual trees. In many other papers, individual trees are identified with a point density of around 7 m-2. Additionally, chapter 2.2 says that the effective density was 4.8 m-2. How did you get the density 5-8 m-2?” REPLY: 4.8 p/m2 is the overall average of the data used for the study while 5-8 referred to the range for the entire ALS coverage. To avoid confusions, the range was substituted by the approximate average ($\sim$ 5 points/m2) (P5547-L5).

12) “Page 5554 line 19: Any kind of area-based metrics can be calculated from ALS data with user-defined spacing and sub-pixel specific locations. It is just a matter of defining the size and position of the area where the metrics should be calculated.” REPLY: The sentence referred to a comparison with optical ground-based HP or LAI-2000, which is explained in the beginning of the sentence.

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