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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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Editor – Prof. Wolfgang Wagner

We greatly appreciate Prof. Wagner's careful and efficient attention to our study and its review process. As a result of the valuable interactive discussion with four reviewers and the Editor, an improved revised manuscript is ready for submission [including a brand-new figure (Figure 3)]. Nearly all of the reviewers' and Editor's major comments were related to discussions about alternative approaches to the one chosen and defended in the current study rather than on technical facets of our method, which were

only subject to minor remarks. We have therefore carefully included more nuanced discussions related to the reviewers' questions and concerns in the revised manuscript while seeking not to significantly increase its length. The open interactive discussion itself is a rich source of scientific knowledge that distinguishes HESS and can be consulted by interested readers.

While supportive of our manuscript, the Editor has fundamentally identified two concerns: 1) that reprojecting ALS data in a polar coordinate system to generate synthetic fisheyes might not be the "right" approach, and 2) that the input of the resulting metrics into hydrologic models has not yet been tested.

1) We agree that there might be a number of approaches that can produce more accurate results when estimating structural metrics, and that generating synthetic hemispherical images is only one of many methods that can be undertaken. However, any procedure using discrete ALS, especially with low return densities, will have to deal with the fact that this technology shows a minimum portion of real canopies and cannot reveal the location and shape of complex structural elements. Therefore, we will always need a "real" version of the forest architecture to reconstruct the canopies and optical hemispherical photography (HP) is a valid means to provide this. Hemispherical projection of 3-D structure has a long established history and is a proven and reliable way to estimate radiative transfer and snowmelt in a forested environment. This has been carefully addressed in our replies to Reviewer #1 (comments #6 and #7) and Reviewer #4 (comments #1 and #2).

2) We have added a last paragraph in the introduction to immediately communicate to the reader that hydrologic models are not tested in the current article, and the corresponding justification: "The analyses of this study are focused on obtaining the forest structure metrics that are currently used by most hydrologic models at any point within an ALS point cloud. The direct input of these remotely-sensed variables into the models is not tested because the main benefit of this methodology is the better characterization of canopy structure in space rather than the simulation of hydrologic

processes at the point level, which can be achieved with traditional optical HP. Future work will take advantage of the opportunity to generate thousands of synthetic hemispherical images derived from ALS to assess the spatial distribution of forest structure metrics relevant to hydrologic modeling at the watershed level, and later fulfill the ultimate goal of allocating fully-distributed, spatially explicit versions of these metrics to the models." This is further developed in the conclusions, where this paragraph was added: "This work represents the first step towards the development of methodologies capable of obtaining fully-distributed versions of the forest structure variables that are needed to parameterize current physically-based hydrologic models. The next stage consists of correlating these metrics âĂŤnow available at any location within the spatial extent of an ALS datasetâĂŤ with satellite-derived spectral indices in order to obtain fully-distributed structural variables to replace the bulk and discrete vegetation classes that are currently used. The ultimate goal is to input these detailed, spatially-explicit and continuous versions of the variables into fully-distributed models to evaluate the changes in model efficiencies when estimating SWE accumulation and ablation as well as streamflow generation. A different line of research should directly use the 3-D capabilities of ALS and alternative metrics derived from this technology to redesign physically-based equations that model hydrologic processes." With these additions, we request to maintain the current title of the article because it is targeted to hydrologists, which are increasingly being trained in remote sensing techniques and can test the approach with alternative datasets. The article needs to emphasize that it focuses on obtaining the metrics that are currently used for hydrologic modeling.

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