

Terrestrial LiDAR-based tree/stand model that can simulate light interception and photosynthesis of branches, individuals, and a stand

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Highlights: We developed a tree/stand model that simulates light interception and photosynthesis of first-order branches individuals, and a stand. The architecture of modelled trees was generated using tree skeletons (a main trunk and basal part of first-order branches) extracted from terrestrial LiDAR data and some architectural rules to add foliage to branches.

Keywords: first-order branch, light interception, photosynthesis, terrestrial LiDAR, tree architecture

Although terrestrial LiDAR has been used to extract architectural information of trees (e.g. Kato et al. 2011), the obtained architectural information has been rarely used in functional-structural plant models. In this study, we developed a tree/stand model by combining the tree skeletons extracted from terrestrial LiDAR data and some architectural rules describing extension of foliage of branches (Delagrange and Rochon 2011) in order to simulate light interception and photosynthesis of branches, individuals, and a stand.

We obtained 3D point cloud data for eight *Betula platyphylla* trees (14.6 – 18.3 m in height) using a terrestrial LiDAR, and extracted architectural information of main trunk (3D position of stem base and tip of main trunk) and first-order branches (position, diameter, and direction of branch). We also measured length, width, and thickness of foliage of 129 first-order branches and obtained architectural rules to predict the expansion of branch foliage from the basal branch diameter that was extracted from LiDAR measurements. We added the predicted foliage to extracted tree skeletons to obtain tree mock-ups (Fig. 1), and voxelized them (Fig. 2). The hourly amount of light intercepted by voxels was determined by a ray tracing method, and converted to hourly photosynthetic gain. The Hourly photosynthetic gains of voxels were summed up to obtain values for branches, individuals, and a stand.

The developed model calculated diurnal changes in photosynthetic gains of branches realistically including the effect of mutual shading among branches belonging to the same and neighbouring individuals (Fig. 3).

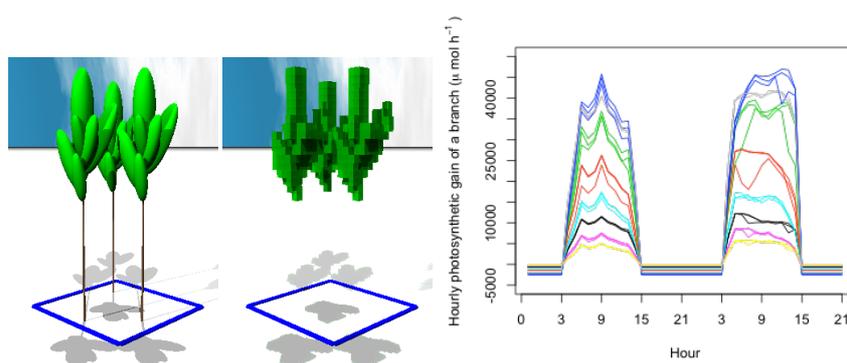


Fig. 1 (left). Modelled trees.
Fig. 2 (center). Voxelized foliage.
Fig. 3 (right). Predicted hourly photosynthetic gain of branches.

LITERATURE CITED

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