SIMULATION OF TREES IN HELIOS++

STUDY ON MODEL COMPLEXITY

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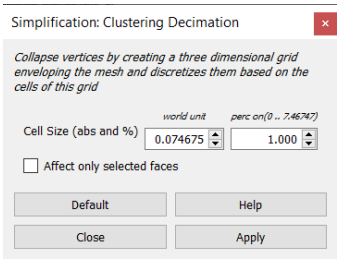
INTRODUCTION

This study compares tree models of different complexity for simulation in ULS contexts. Tree models were provided by SCION, and were created using the “The Grove 10”-Plugin[1] in Blender. For subsequent analysis, one of the Pinus Ponderosa models was selected. It is pictured on the right.

The goal of the simulation is validation of flight plans, where especially ground coverage and point densities are of importance.

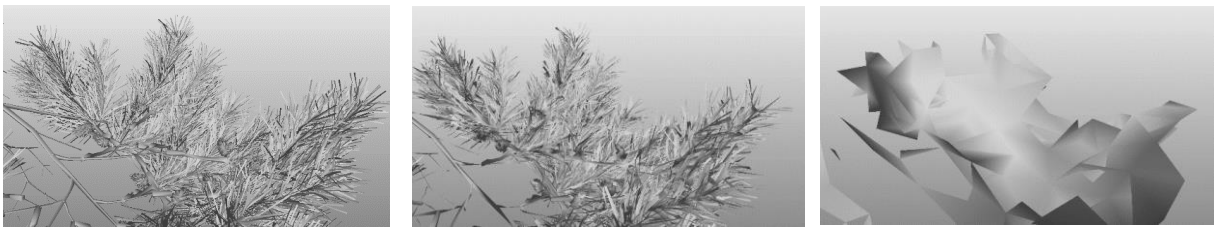
DATA PREPARATION

The mesh model was exported to obj, and subsequently simplified using MeshLab[2] (2020.12). Two simpler models were created using the “Filters ->Remeshing, Simplification and Reconstruction -> Simplifcation: Clustering decimation” Tool, which has the following settings:



File	Simplification Settings	File Size	No. Faces / No. Vert.
ponderosa.obj	(none)	1,028 MB	6,338,932 / 7,744,412
ponderosa_med.obj	10 %	193 MB	3,762,126 / 3,199,303
ponderosa_min.obj	1 %	4.6 MB	54,535 / 18,167

The simplified objects are shown below, including some details on the branches:



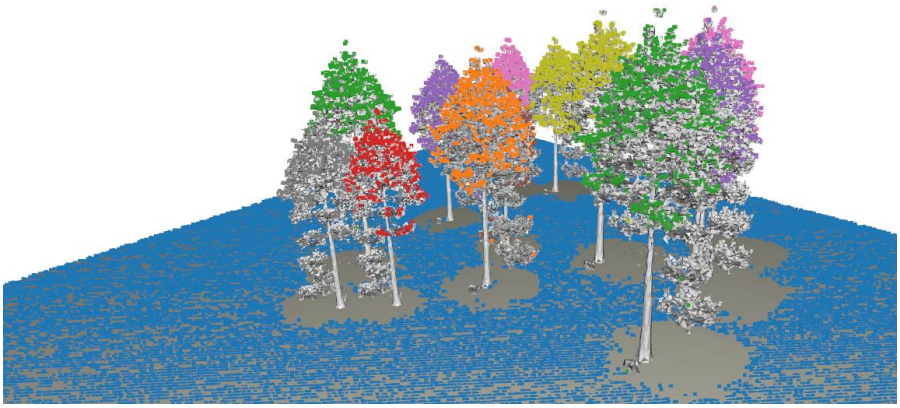
Twig detail. Left: orignal model, center: simplified model „med“, right: simplified model *„min“*

[1] https://www.thegrove3d.com/releases/the-grove-release-10/
[2] https://www.meshlab.net/

Full tree. Left: orignal model, center: simplified model „med“, right: simplified model *„min“*

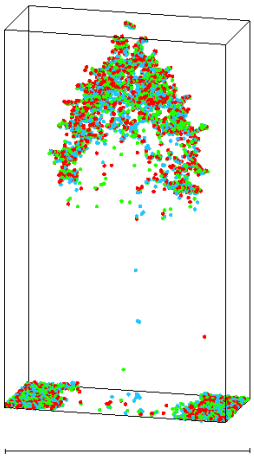
SIMULATION SETTINGS

Twelve copies of the exact same tree were placed into a HELIOS++ scene, rotated, shifted and scaled to create a loose group of trees. Some of the canopies were touching or slightly intersecting. For the non-simplified version, only one tree was placed in the center of the scene. A single flight line was simulated using a RIEGL VUX-1UAV scanner, on a platform moving with 5 m/s flight speed at 30 m AGL and 300 kHz pulse repetition rate. The maximum off-nadir scan angle was set to 60 degrees. The scene using the min-models and the resulting point cloud are shown below:

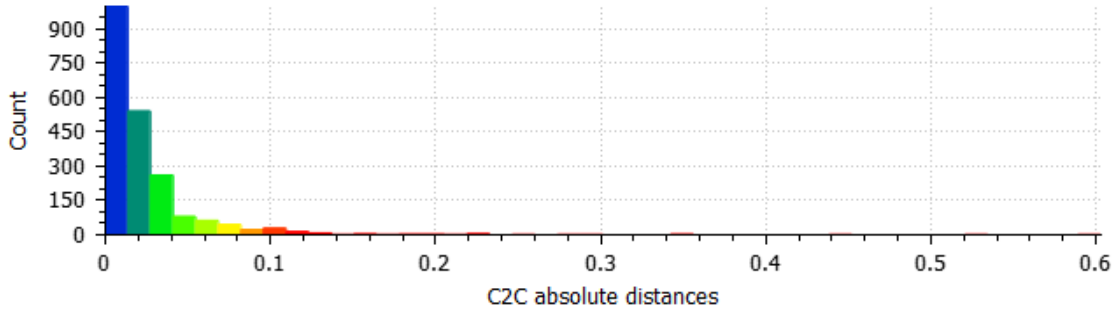


RESULTS

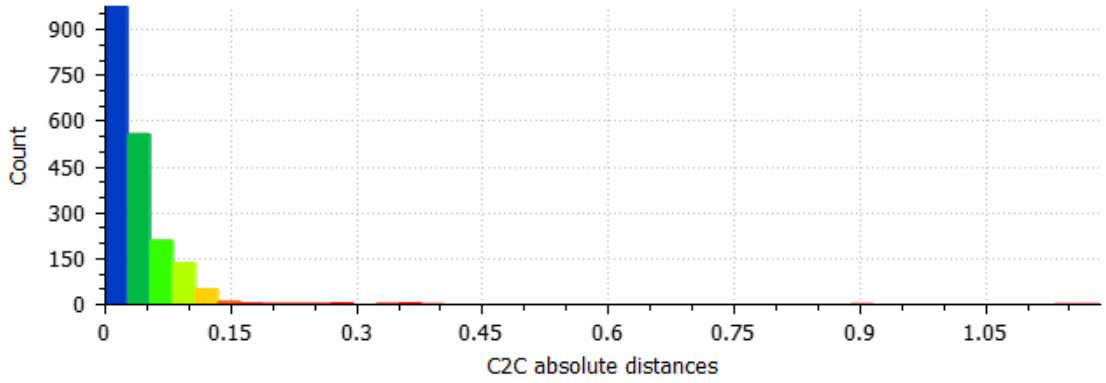
Resulting point clouds were loaded into CloudCompare[3]. A section through the central tree, with all three acquisitions overlayed is pictured on the right. The point cloud resulting from the full model is shown in red, from the med-model in green, and from the min-model in blue. Differences are present, but seem minimal; there is no better canopy penetration with any of the models.



Cloud-to-cloud distances in the canopy are <0.15 m for the min-model and <0.10 m for the med model, when compared to the full model, as shown in the histograms below:



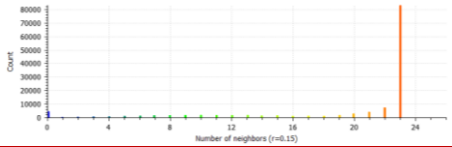
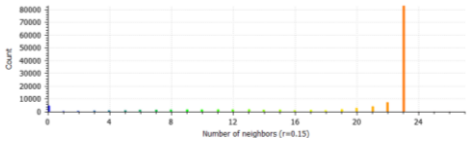
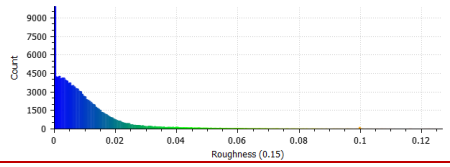
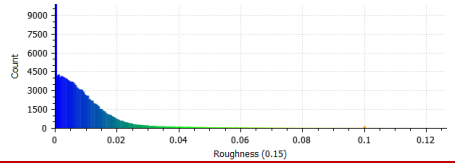
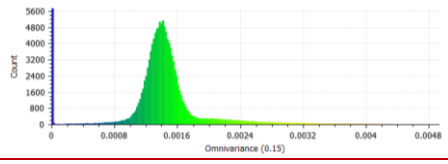
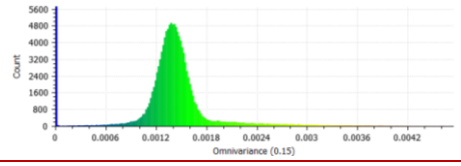
Histogram for the cloud-to-cloud distances between the med-model and the full model.



Histogram for the cloud-to-cloud distances between the min-model and the full model.

[3] https://www.danielgm.net/cc/

Further comparisons on the med- and min-models were carried out with respect to their distribution of a) Number of neighbours, b) Roughness and c) Omnivariance, considering a local neighbourhood of 0.15 m radius. Histograms are shown in the table below.

Measure	med-model	min-model
No. neighbours		
Roughness		
Omnivariance		

CONCLUSION

The cloud-to-cloud differences between both simplified and the full model, show values up to 0.15 m, which is within the expected movement of the canopy due to wind or similar effects. Therefore, we do not deem these differences to be significant, and suggest that the simplification is valid. Especially concerning penetrability of the canopy, there seems to be no difference in the choice of model, as can be seen in the distribution of ground points.

Further analysis of geometric features for the two models showed no major difference. We therefore think it appropriate to use the min-model for the purpose of flight plan validations.