EGU22-11723
https://doi.org/10.5194/egusphere-egu22-11723
EGU General Assembly 2022

Improving Local Maxima-based Individual Tree Detection using statistically modelled Forest Structure Information

Christoph Schaller[1], Christian Ginzler[2], Emiel van Loon[3], Christine Moos[4], and Luuk Dorren[4]
[1]Bern University of Applied Sciences, Zollikofen, Switzerland (christoph.schaller@bfh.ch)
[2]Swiss Federal Research Institute WSL, Birmensdorf, Switzerland
[3]University of Amsterdam UVA - IBED, Amsterdam, the Netherlands
[4]Bern University of Applied Sciences, Zollikofen, Switzerland

Laser scanning-based tree detection has been used for many years to complement sample data of forest inventories. Local Maxima (LM) detection methods are suitable for individual tree detection in the forest canopy and allow for detection over large areas due to their computational efficiency. However, the performance of LM methods depends on factors such as the resolution of the input data (point density of aerial laser scanning (ALS) and spatial resolution of the derived rasters), the pre-processing of the input data as well as the structure and species of the detected forest. The main objective of our study was to evaluate to what extent LM tree detection can be improved by considering prior knowledge about forest structure using statistical modelling. To achieve this goal, we developed a statistical model for selecting between 10 different crown height model (CHM) pre-processing methods based on forest structure variables derived from remote sensing data. We fitted linear regression models predicting the error between the number of detected trees and the field inventoried number of the trees reaching the canopy in the sample plot. The model used dominant canopy height, the degree of coverage overall and for different forest layers derived from the CHM, the dominant leaf type derived from Sentinel-2 data, and terrain characteristics as explanatory variables. The model performance was evaluated by assessing tree detection errors using all national forest inventory plots in Switzerland using 10-fold cross-validation. The results showed a reduction of the RMSE to 91 stems per ha (respectively 1.3 when normalized by the inventoried stem number) using the model-based pre-processed CHM for detection compared to 205 stems per ha (normalized = 4) when detecting trees using an unprocessed CHM (number of used inventory plots n=5254). Excluding inventory plots with an ALS point density of less than 15 points per square meter (n=3797) improved the RMSE to 89 stems per ha (normalized = 1.25).The RMSE further improves to 85 stems per ha (normalized = 1.2) by additionally excluding plots with more than 6 years between ALS acquisition and inventory (n=2676). Although the results show a clear reduction of the detection error by our model, they also indicate potential for further refinements. Especially the integration of high-quality ALS data (becoming available for the entire area of Switzerland until 2024), detailed tree species data, and additional, more recent inventory data are recommended. In the future, a combination of our method with point cloud-based approaches will probably be able to further reduce detection errors at national scale.