



Forecasting forest dynamics with the individual-based model LAVESI across the Siberian treeline: from UAV surveys to simulations

A

Forest inventories

Our motivation is to provide a simple process-chain for easily starting individual-based forest simulations covering the 21st century, based on field-work. We evaluated the use of UAV data in addition to typically recorded forest inventories.

Forest inventories were recorded for a variety of boreal forest types in Siberia (Fig. 1, Kruse et al., 2019a). Two contrasting environments were visited, the tundra-taiga transition zone in Chukotka, Northeast Russia, and the summergreen-evergreen transition in Central Yakutia, Russia.

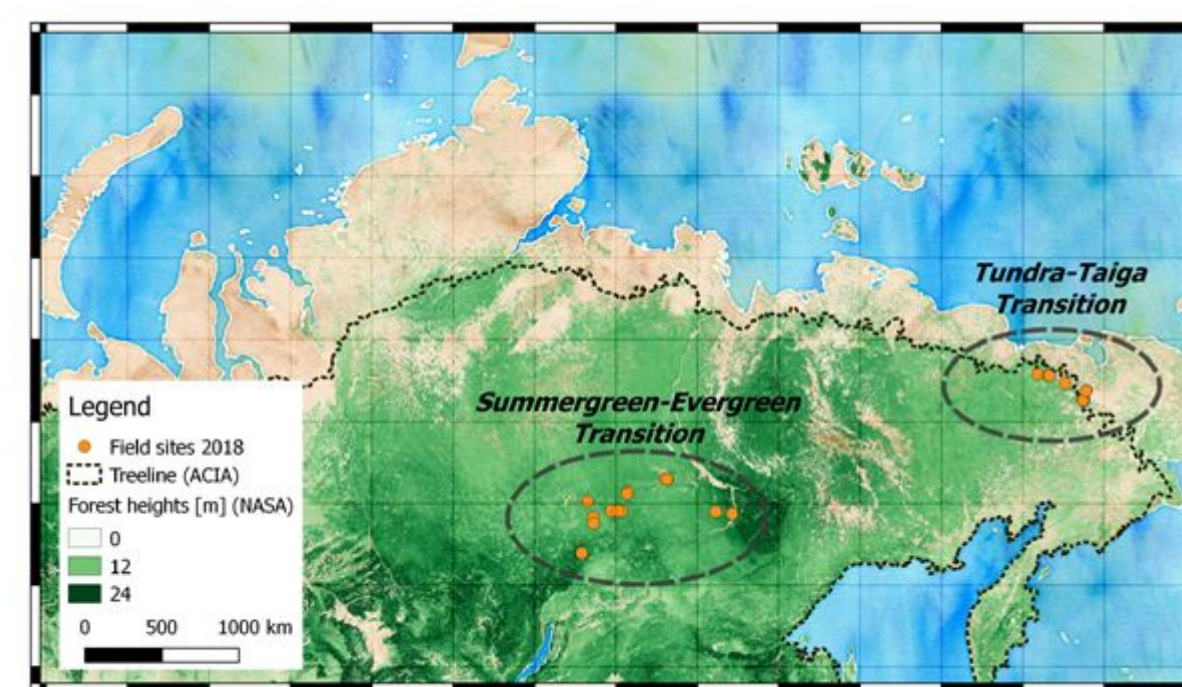


Fig 1: Map of forest distribution and the treeline (dashed line) and field work regions visited in 2018 in Russia.



Dwarf shrub tundra



Open larch forest



Mixed-species boreal forest



Fire-disturbed pine forest

B

UAV surveys and tree detection



UAV-surveys were conducted on 56 plots in 2018, using DJI Phantom4 onboard RGB and an additional RGNir-camera (MAPIR, Survey3) and flying double-grid and circular missions from 30-40 m above liftoff (Kruse et al., 2019a).

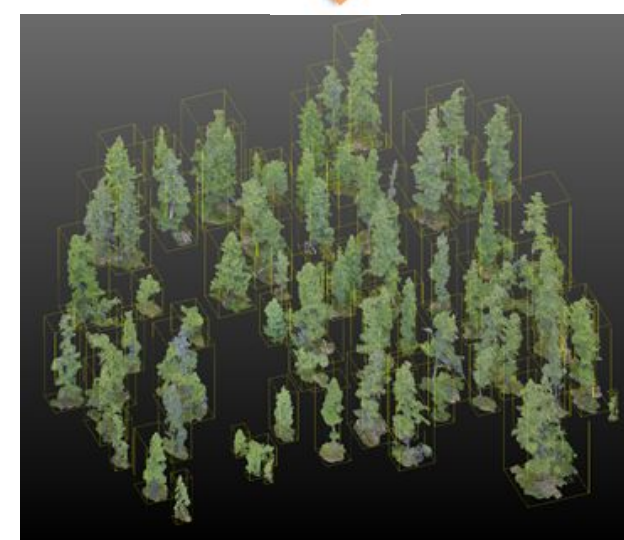


Fig 2: UAV surveys in boreal forests (top). Above ground points (trees) of reconstructed point cloud (bottom).

3D point clouds were constructed in Agisoft Photoscan and the ground points separated from tree layer with a cloth simulation filter (CSF) in R. The low flight height allowed the reconstruction of a high amount of the ground layer below the crowns. However, it also causes missing crown tops at sites with tall trees and dense forests.

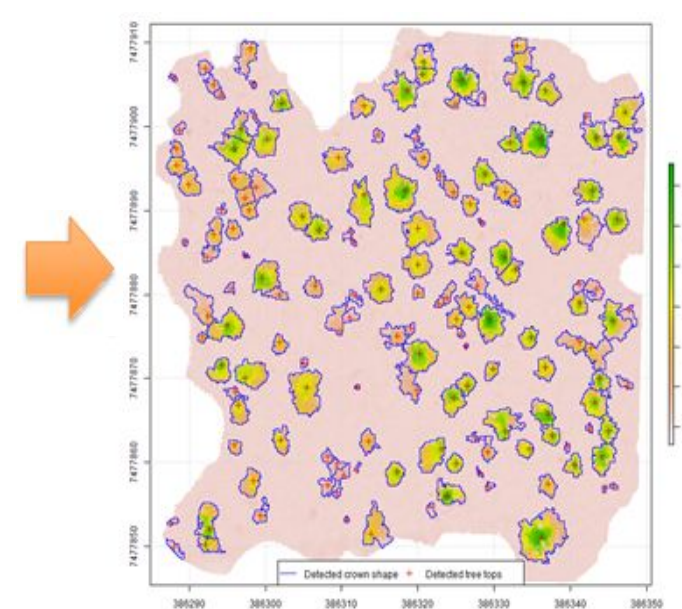


Fig 3: Canopy heights and detected tree tops & crown contours.

Individual tree detection was performed and evaluated on a representative subset of sites (Brieger et al., 2019). In general, the reconstructed forest structure was similar to the forest inventory recorded during field work. Small trees (height below c. 2 m) were not sufficiently recognized.

Involved programs and functions

- pointcloud reconstruction in [Agisoft Photoscan](https://www.agisoft.com/) (<https://www.agisoft.com/>) alternatively one may use [OpenDroneMap](https://www.opendronemap.org/) (<https://www.opendronemap.org/>)
- basic functions of [R](https://cran.r-project.org/) (<https://cran.r-project.org/>) for general handling of data and files
- [R packages for tree detection](https://cran.r-project.org/package=lidR)
 - [lidR](https://cran.r-project.org/package=lidR) (<https://cran.r-project.org/package=lidR>)
 - [RCSF](https://cran.r-project.org/package=RCSF) (<https://cran.r-project.org/package=RCSF>)
 - [ForestTools](https://cran.r-project.org/package=ForestTools) (<https://cran.r-project.org/package=ForestTools>)

D

Forecasts of biomass dynamics



Fig 5: Soil surface biomass sampling was performed for the major dominant taxa. Image: Luise Schulte

Biomass was sampled of tree and shrub individuals and will be used to establish allometric functions for biomass estimation of each simulated tree.

First results of biomass data from the tundra-taiga transition zone in Chukotka can be found on [EGU2020 display D469 in BG3.15](#), by Iuliia Shevtsova et al.

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Take home message

- UAV-based imagery can be used to robustly infer forest inventories, but the current approach underestimate small life stages
- LAVESI can easily run starting with UAV-based forest structures and applied for prediction of forest dynamics, but a wrapper function is needed

Open tasks

- prepare wrapper functions in R for LAVESI to easily process the field data and start simulations with them
- implement more boreal forest species to allow the model for simulating the full range of boreal forests



References

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