A new workflow for generating realistic synthetic airborne laser scanning data of forests

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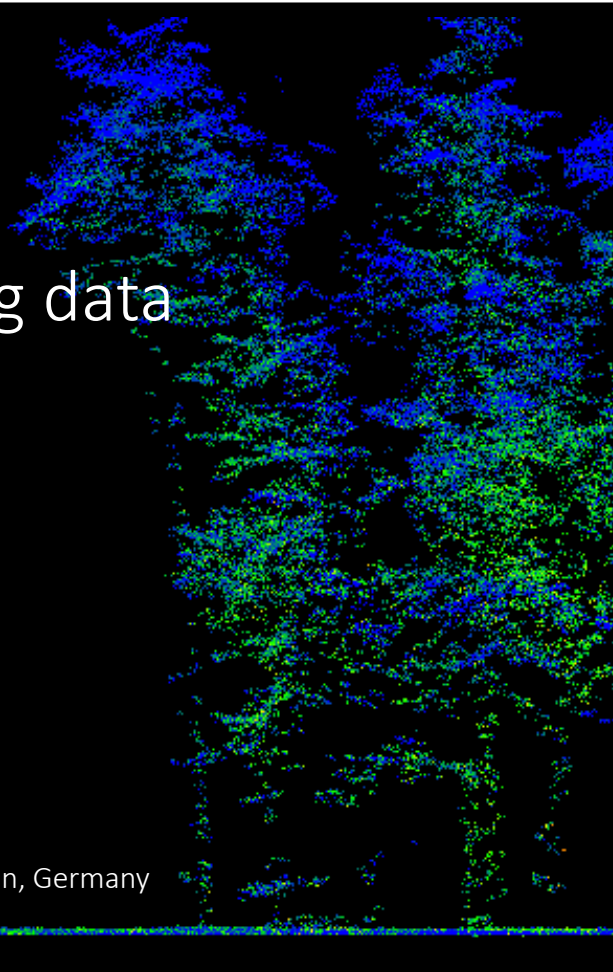
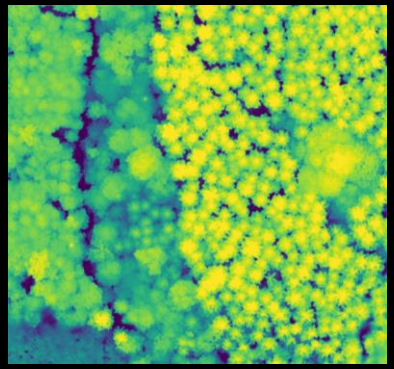
[4] Remote Sensing and Geoinformatics, Institute of Geographic Sciences, Freie Universität Berlin, Germany



Biomass estimation by airborne laser scanning



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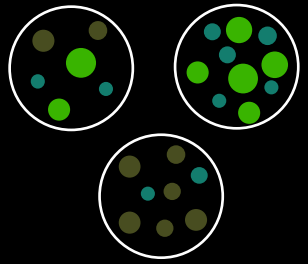

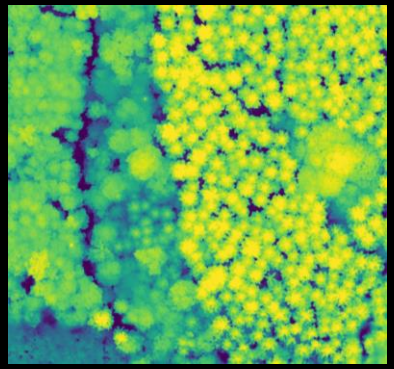

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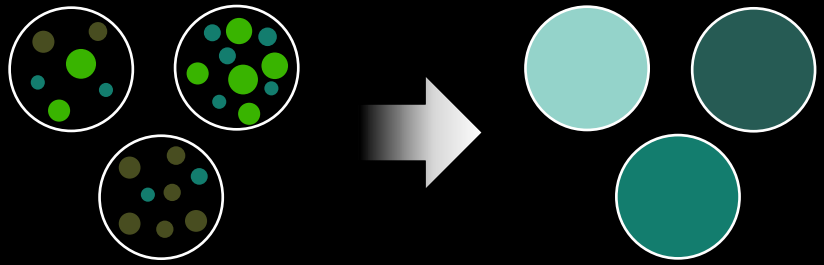

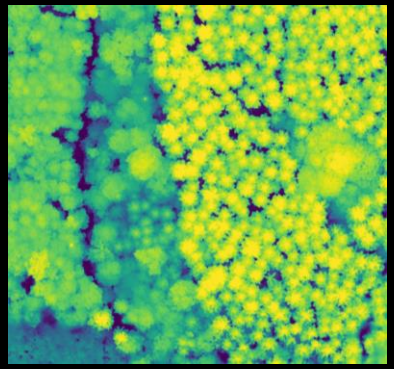

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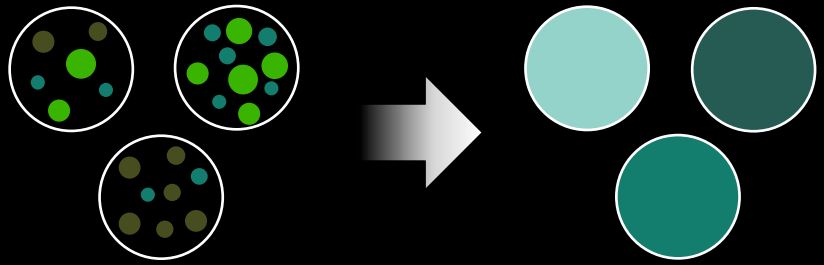

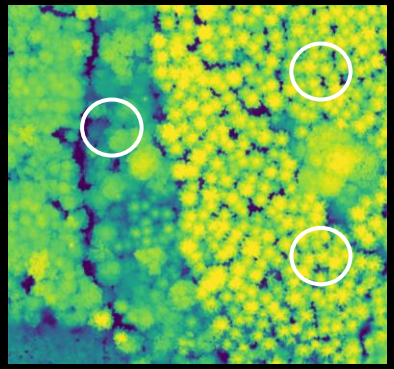

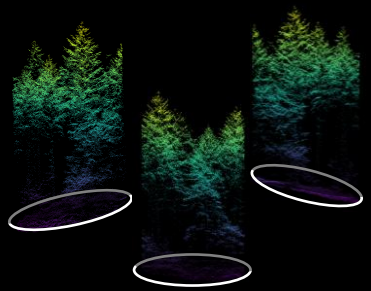

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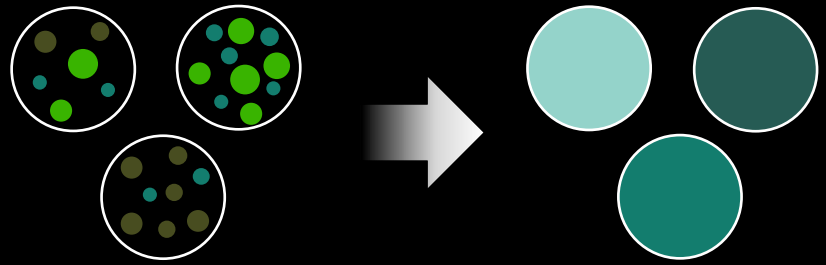

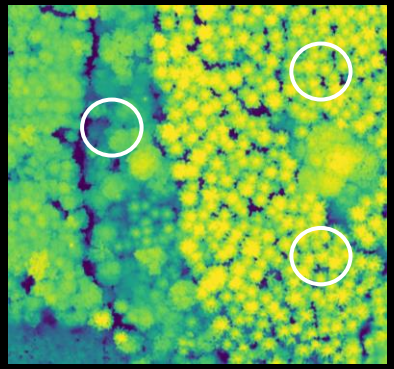

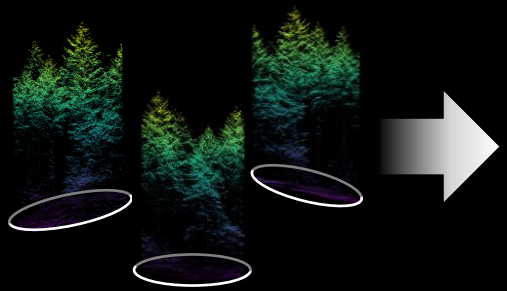

max. height
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height percentiles
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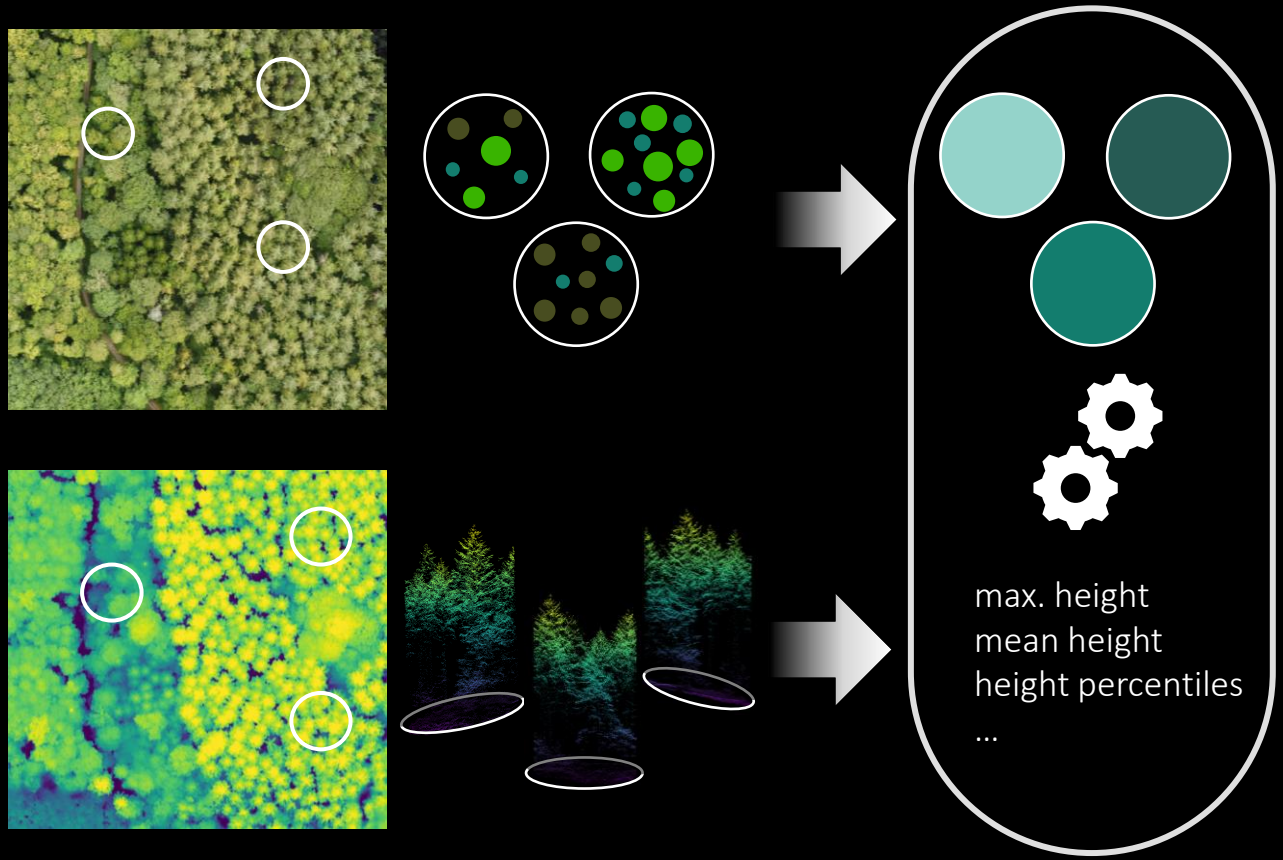
Biomass estimation by airborne laser scanning



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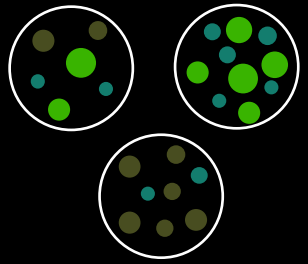

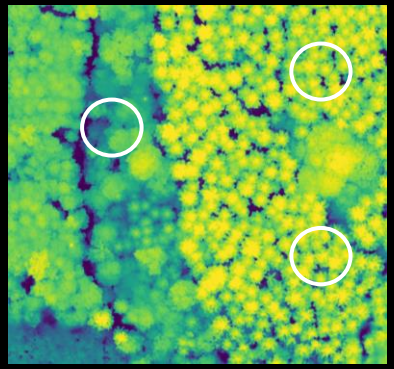

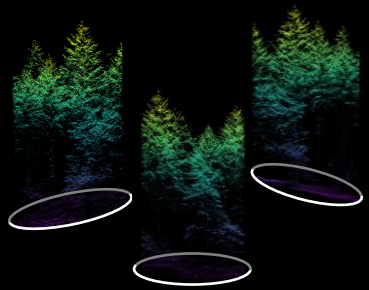

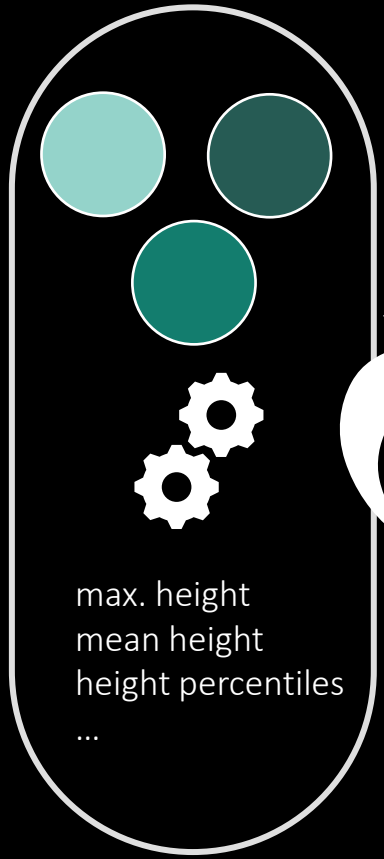

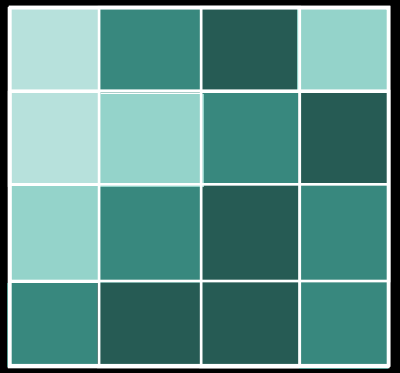

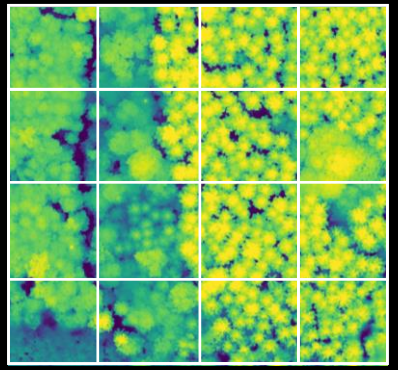

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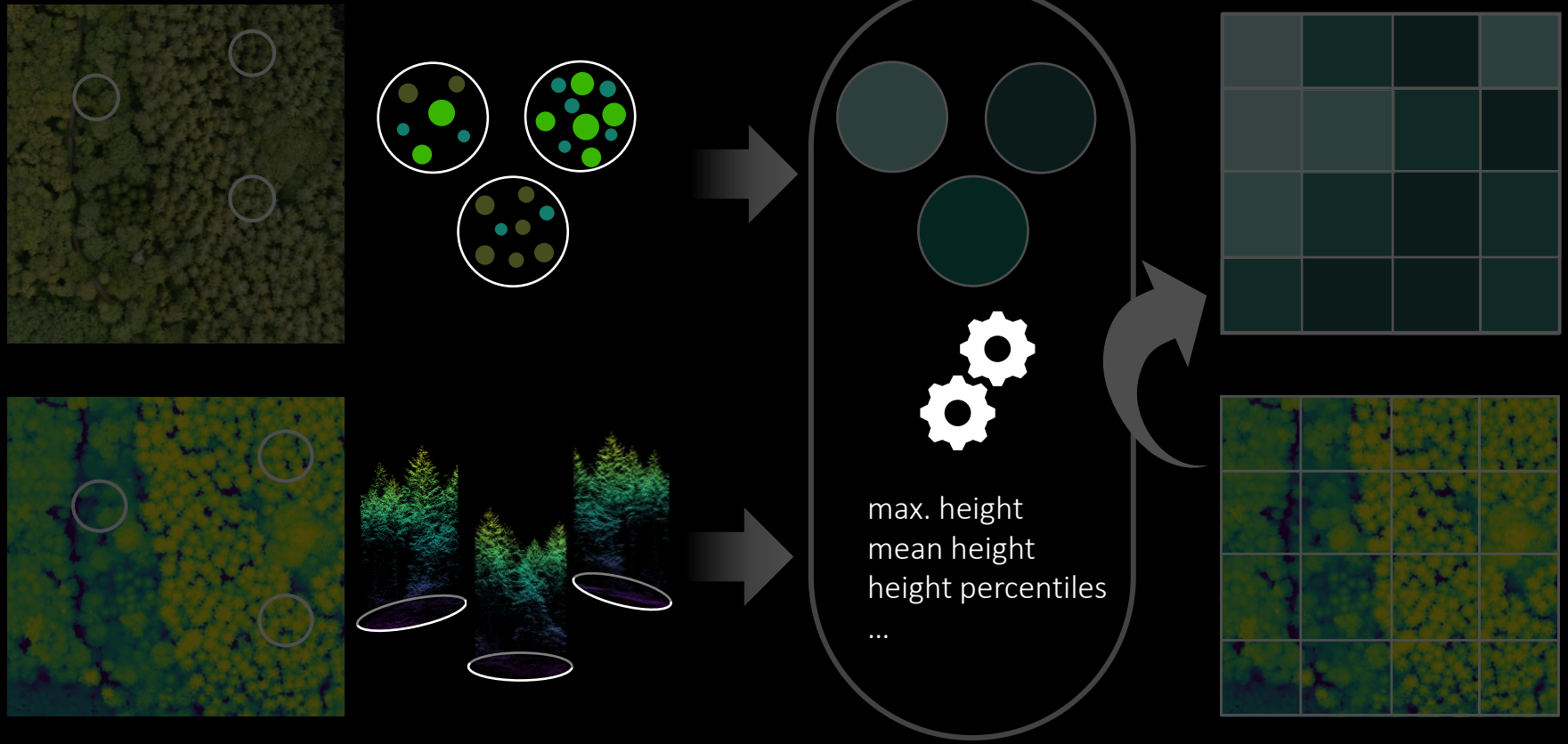

Influencing factors

- field reference data

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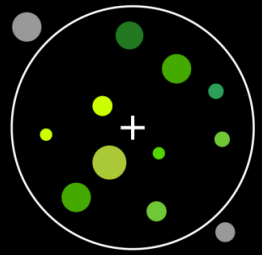
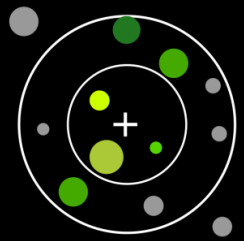
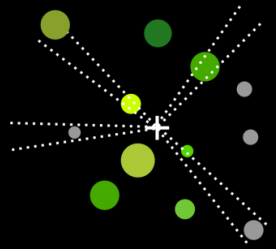


complete inventory



concentric circles



angle count sampling

Influencing factors

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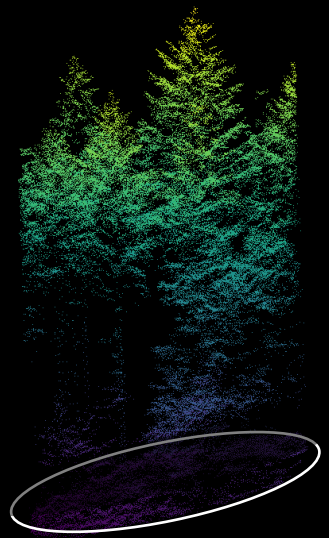
- laser scanning data



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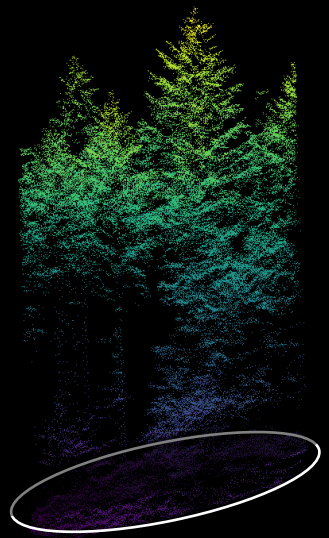

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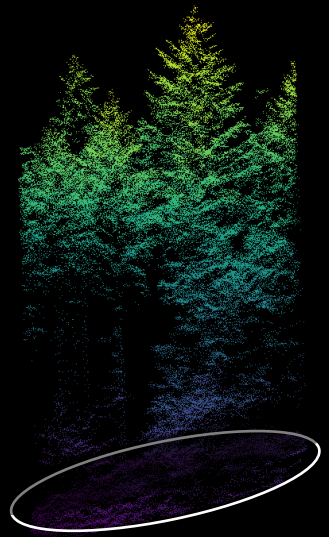

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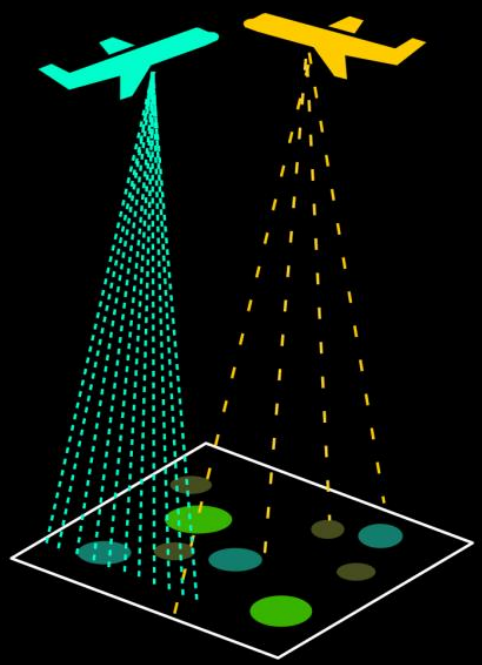
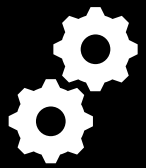
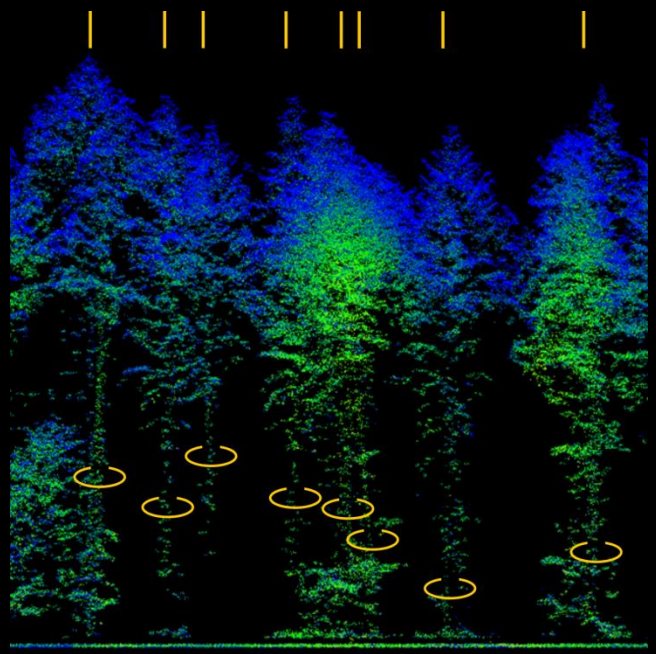


Influencing factors

- field reference data
- laser scanning data
- applied method





Sensitivity analysis & Method development

- field reference data
- laser scanning data
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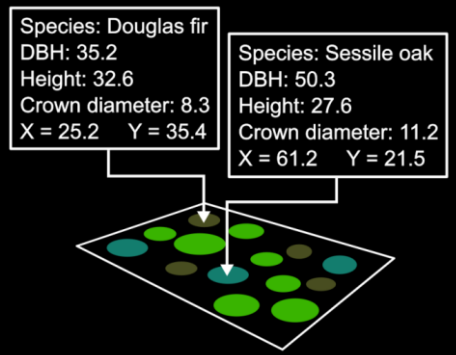

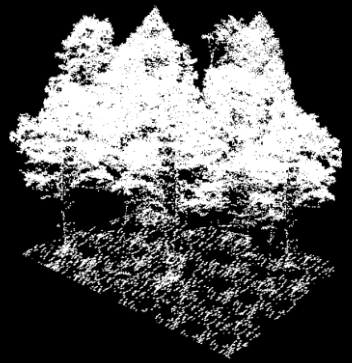

forest stand information laser scanning data

Sensitivity analysis & Method development

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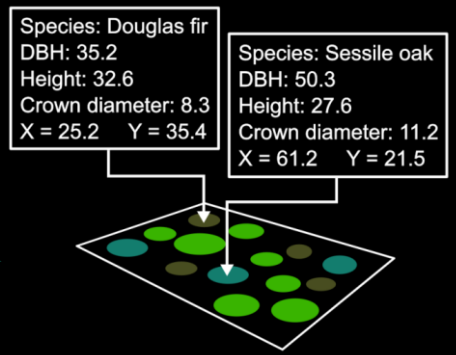
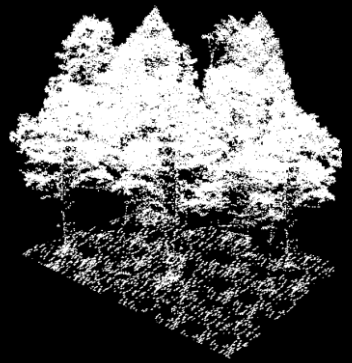
Required:
large amounts of data

synthetic data





forest stand information laser scanning data

Benefits of synthetic data

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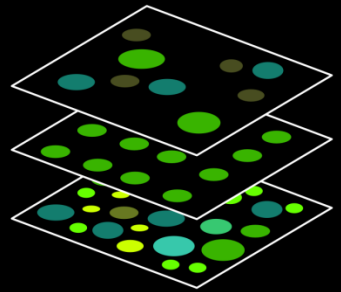
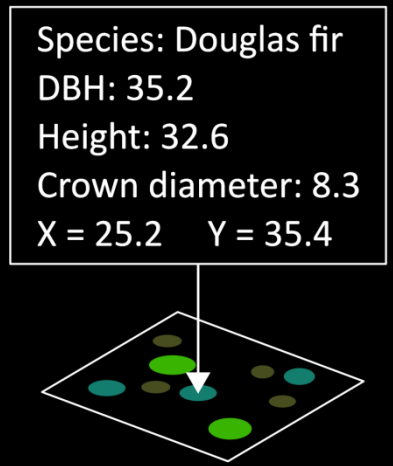
- any forest stand composition



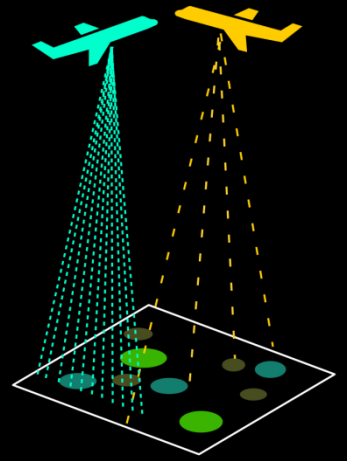
Benefits of synthetic data

- any forest stand composition
- known position and properties of each tree



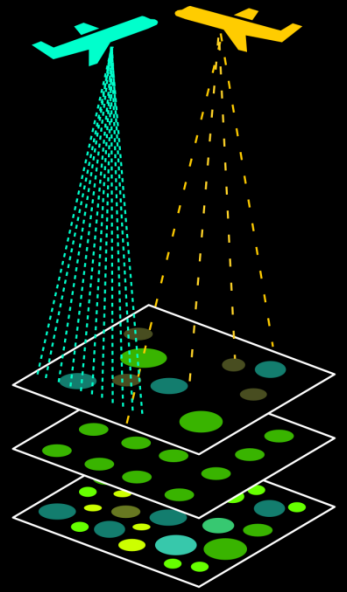
Benefits of synthetic data

- any forest stand composition
- known position and properties of each tree
- any laser scanning acquisition settings



Benefits of synthetic data

- any forest stand composition
- known position and properties of each tree
- any laser scanning acquisition settings
- in theory: unlimited amounts of data



Limits of existing approaches

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tree models

laser scanning simulation

forest stands

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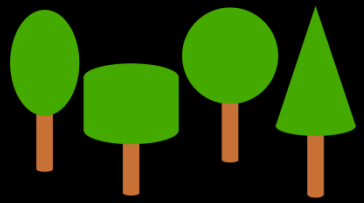

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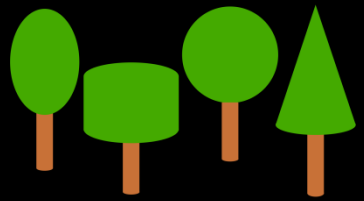

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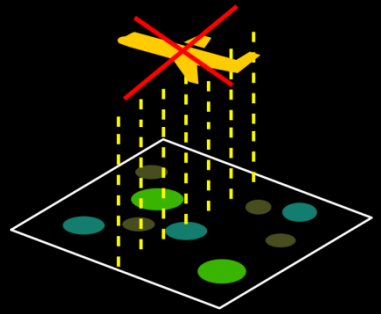

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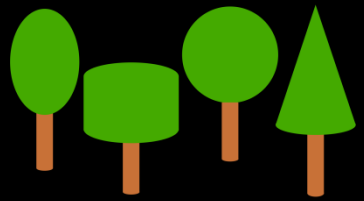

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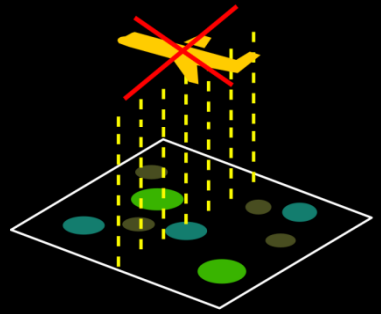

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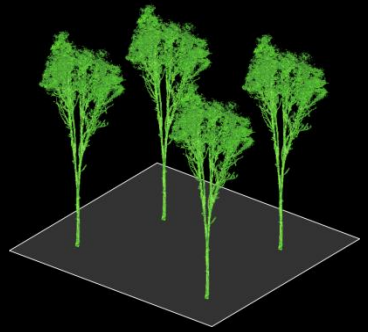

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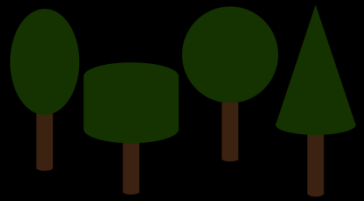

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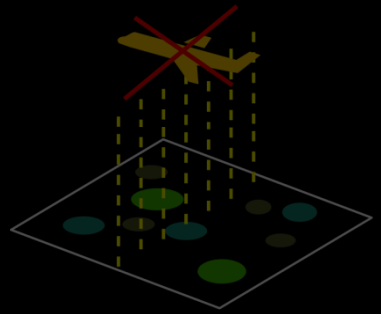

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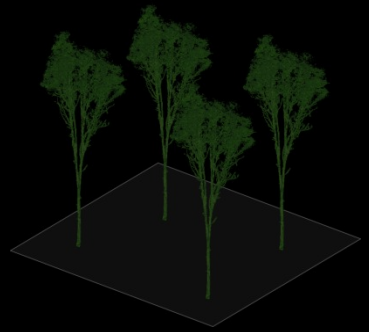

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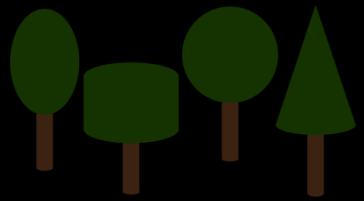

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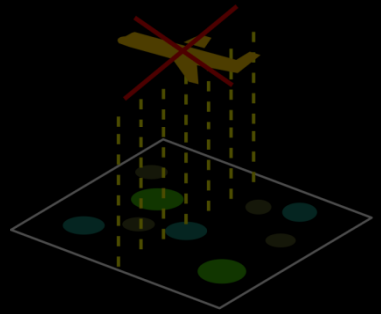

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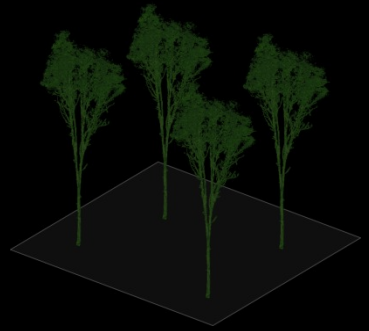

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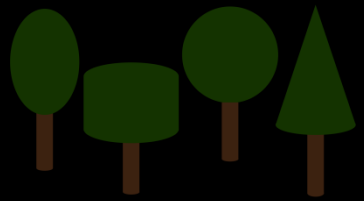

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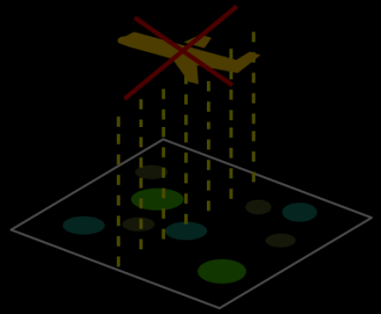

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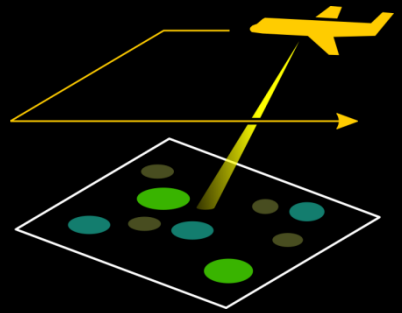

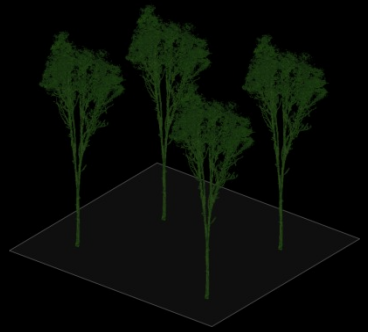

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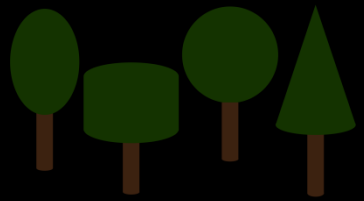

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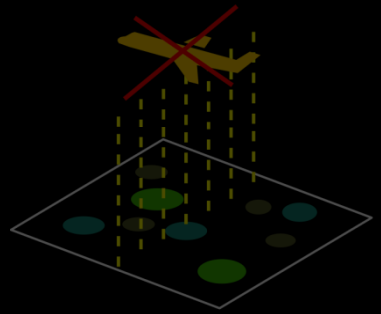

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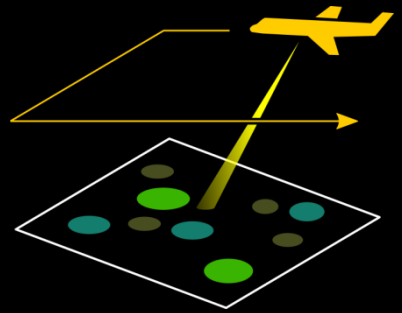
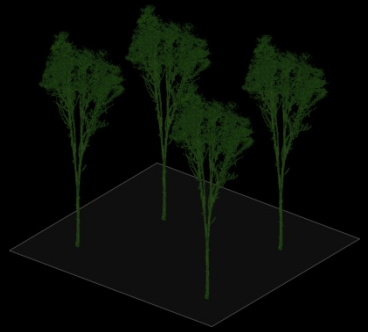
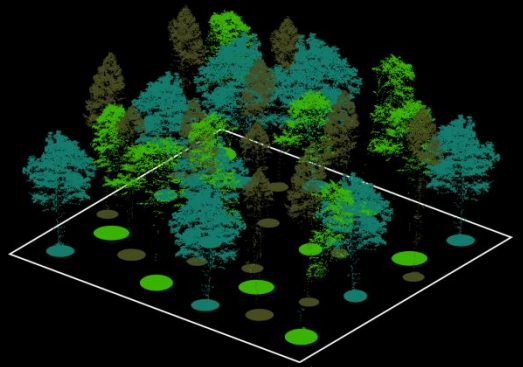


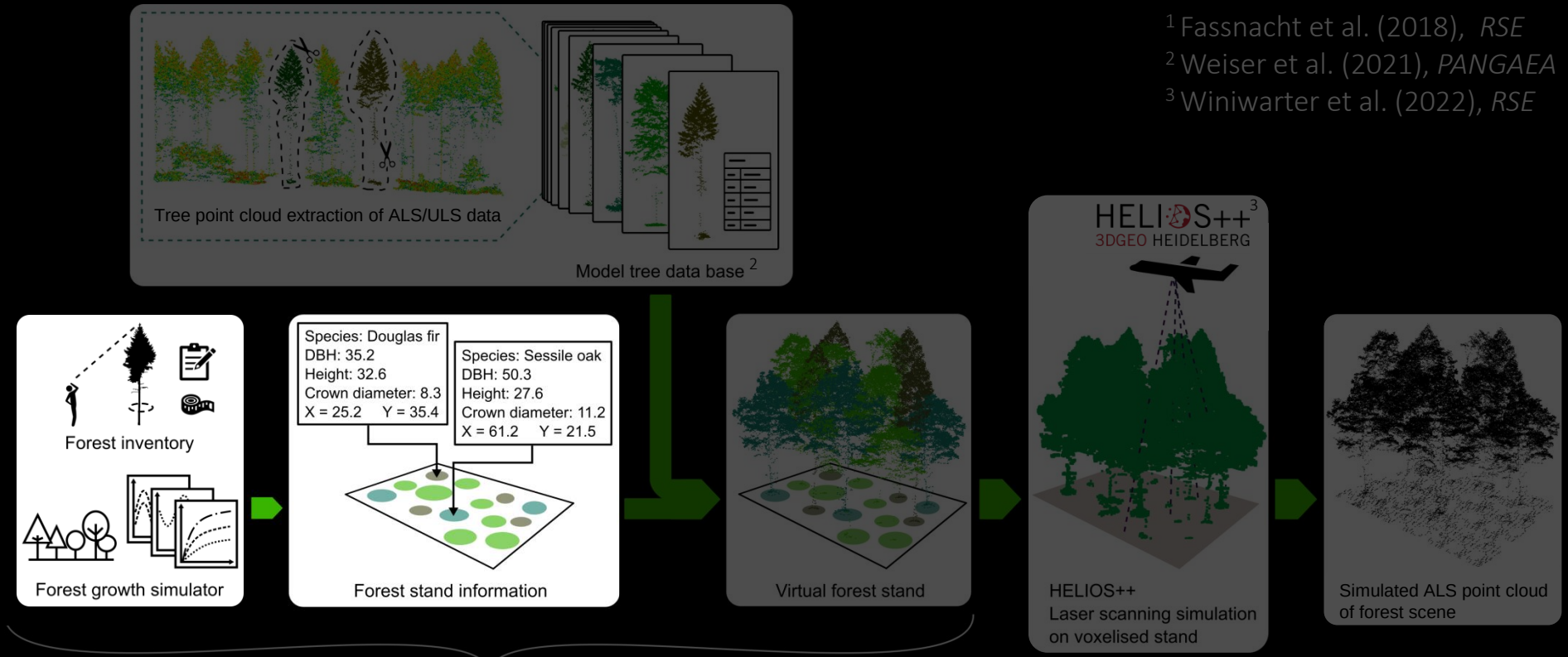


forest stands



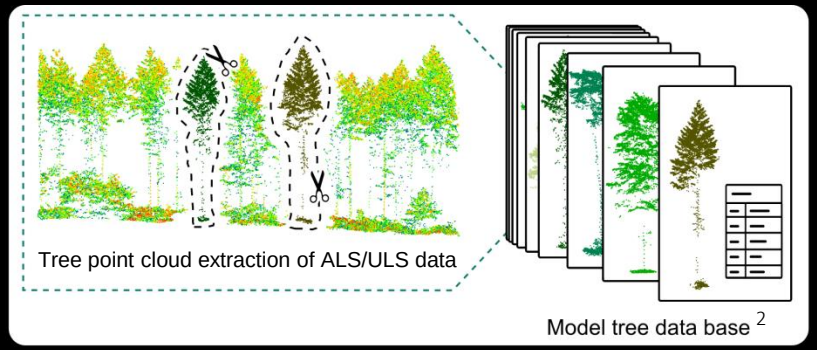
Workflow

Workflow



[1] Fassnacht et al. (2018), *RSE*
[2] Weiser et al. (2021), *PANGAEA*
[3] Winiwarter et al. (2022), *RSE*

Workflow



[1] Fassnacht et al. (2018), *RSE*
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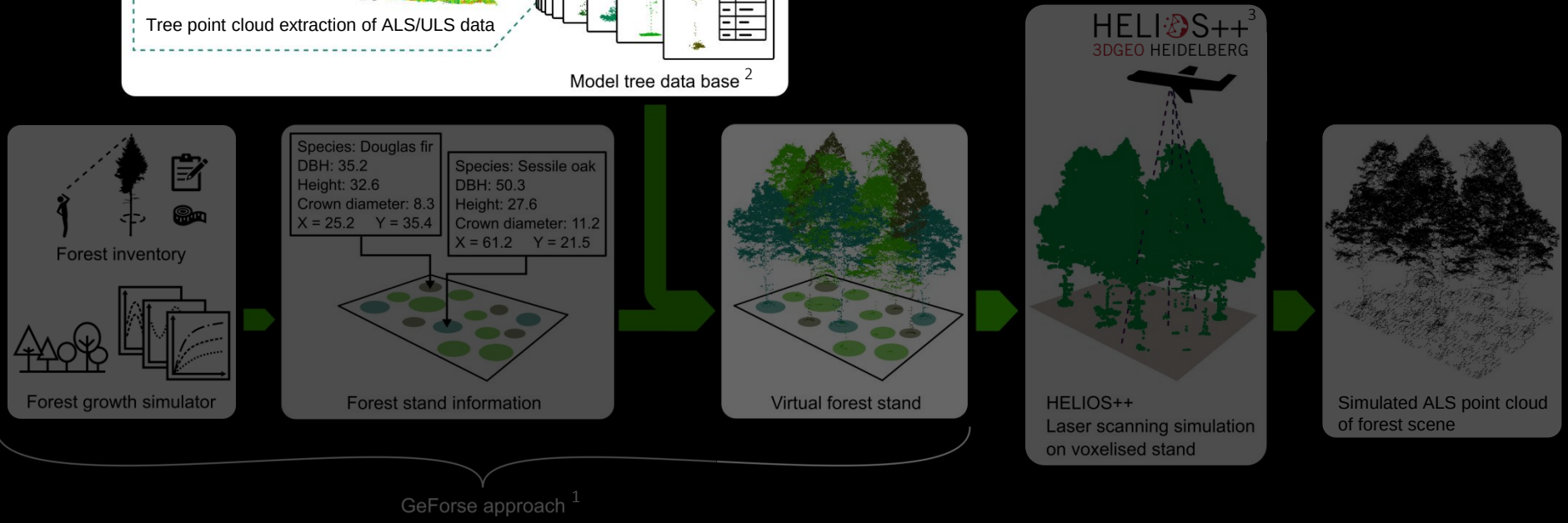
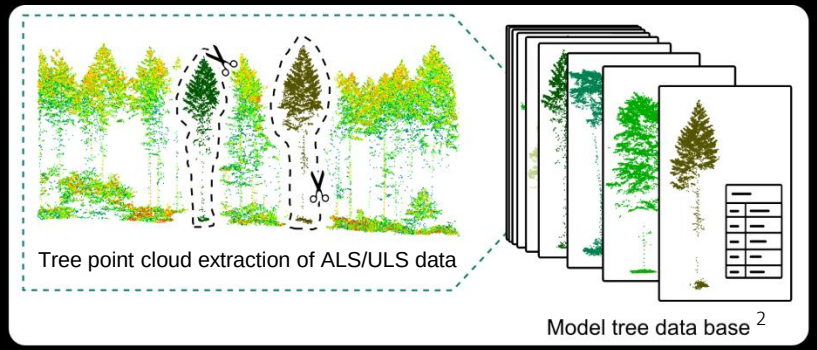


Workflow



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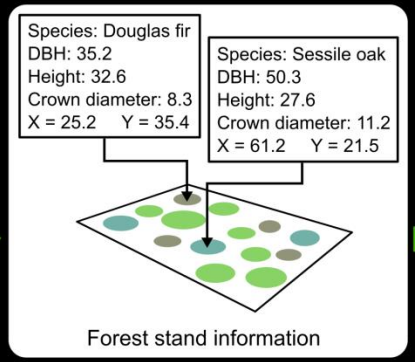
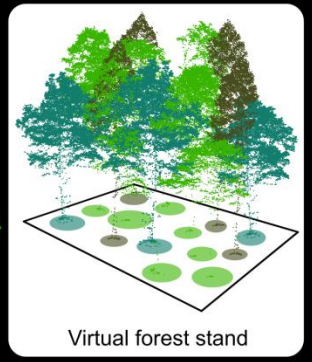
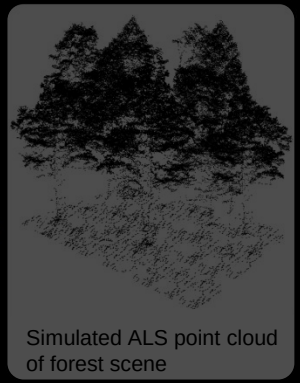
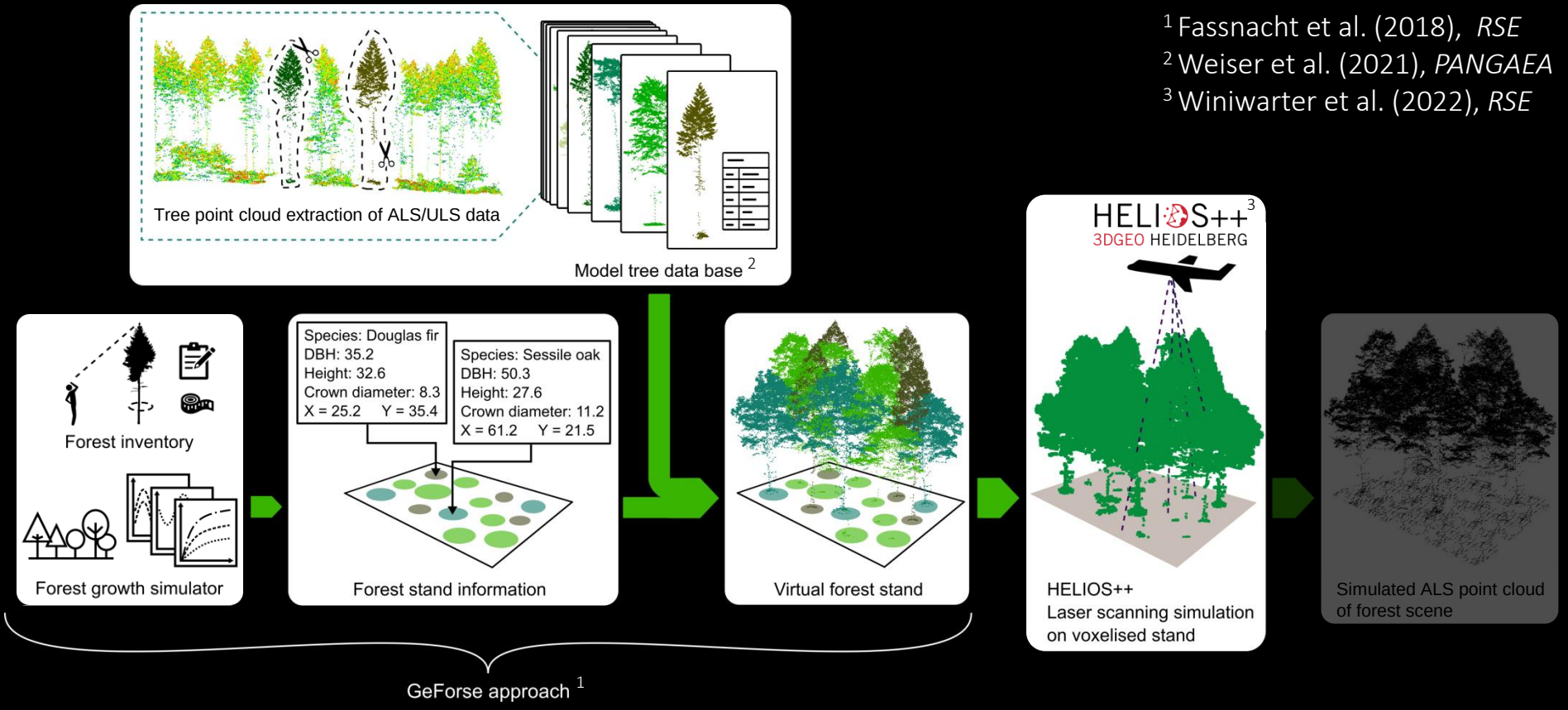






GeForse approach [1]

Workflow



[1] Fassnacht et al. (2018), *RSE*
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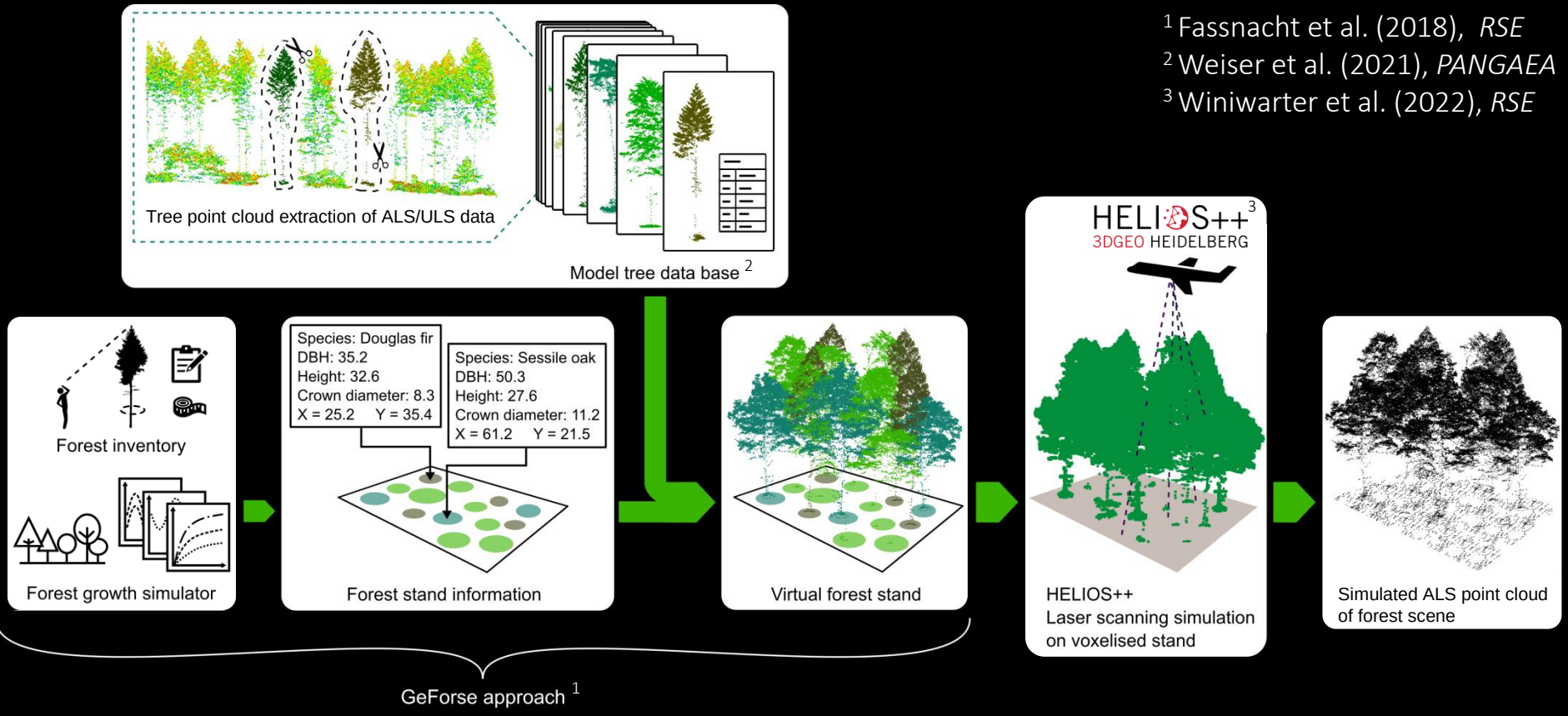
Workflow

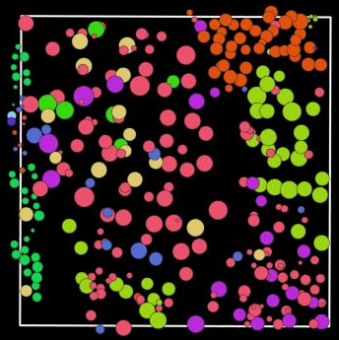


[1] Fassnacht et al. (2018), *RSE*
[2] Weiser et al. (2021), *PANGAEA*
[3] Winiwarter et al. (2022), *RSE*

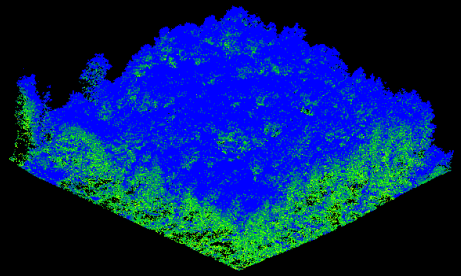
Validation

Validation

forest inventory data



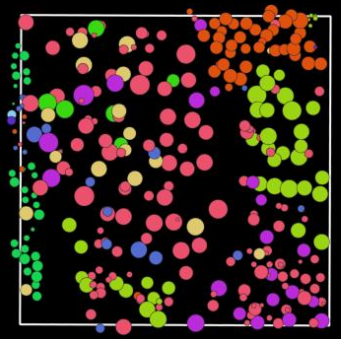
real ALS data

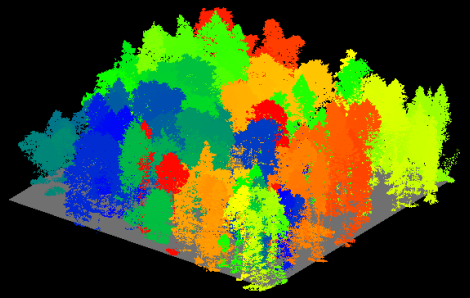


six plots of 1 ha

Validation

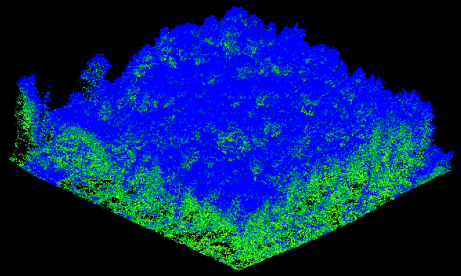
forest inventory data





synthetic forest stand

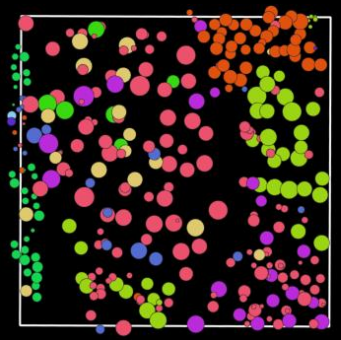
real ALS data

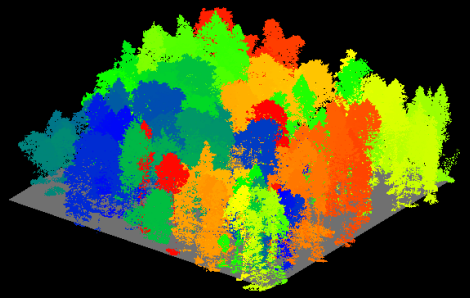


six plots of 1 ha

Validation

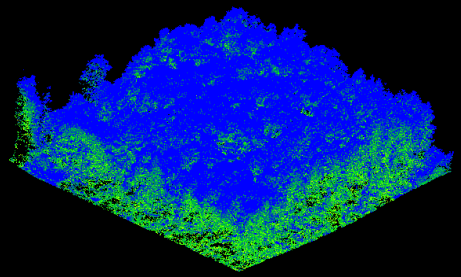
forest inventory data

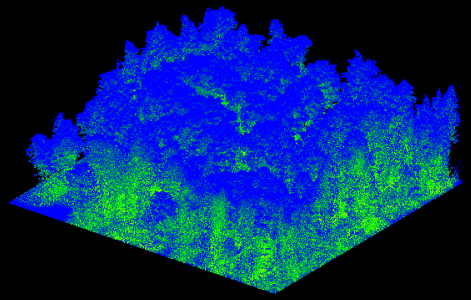




synthetic forest stand

real ALS data



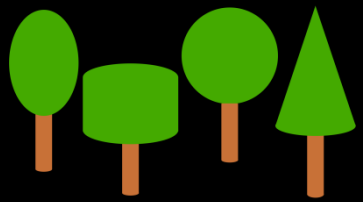


simulated ALS data

six plots of 1 ha

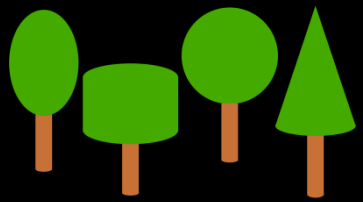
Validation

tree models



Validation

tree models

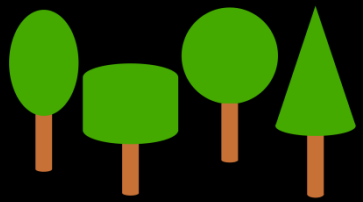


RTM

real tree models

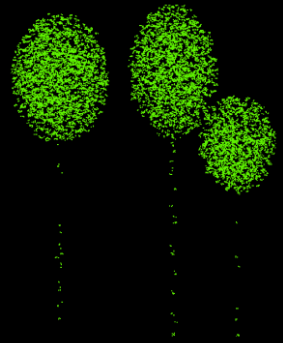
Validation

tree models



RTM

real tree models

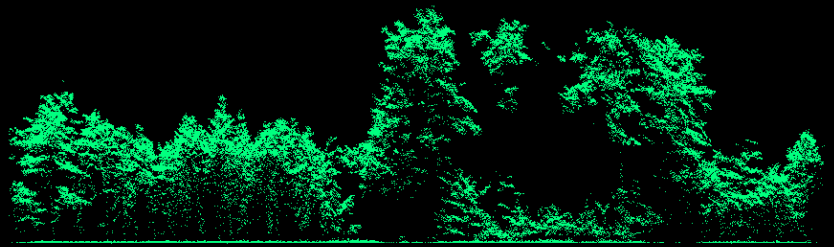


STM

simplified tree models

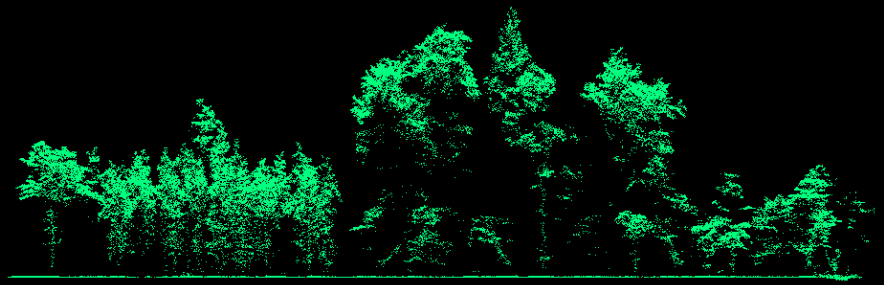
Cross sections

Cross sections

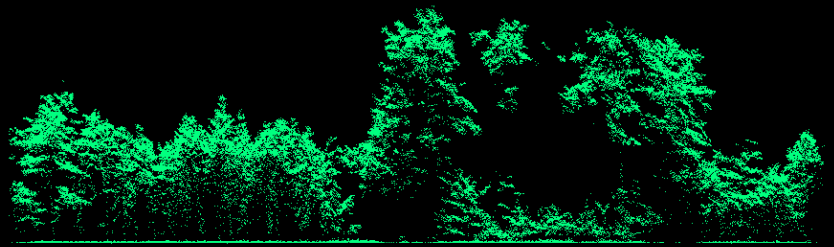


original ALS data

Cross sections

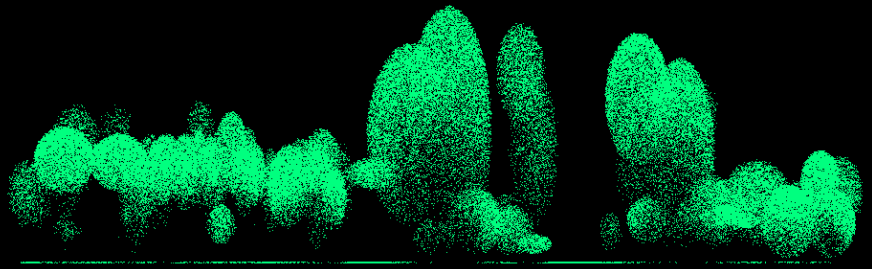


simulated RTM data



original ALS data

Cross sections



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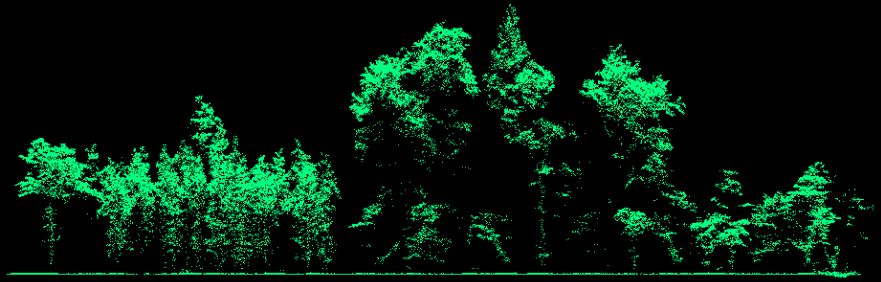

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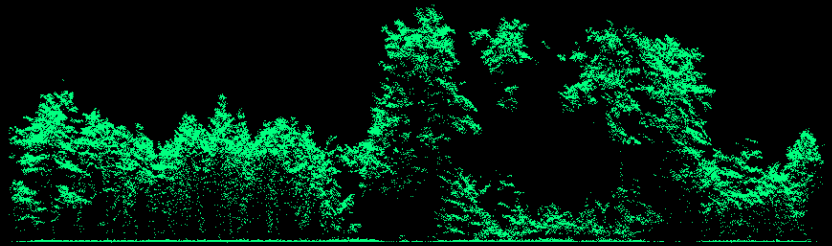

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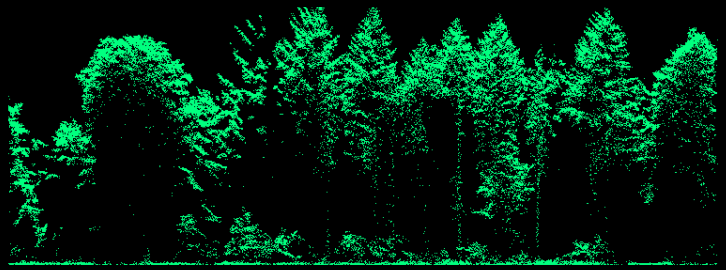
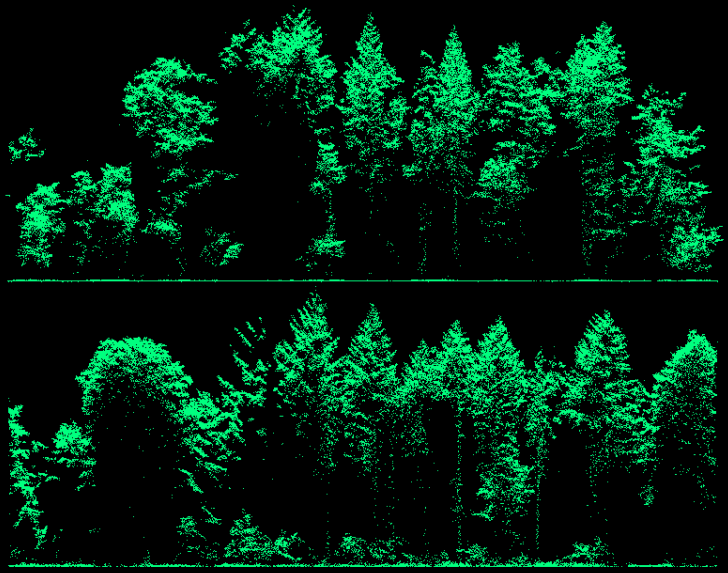
Cross sections



original ALS data

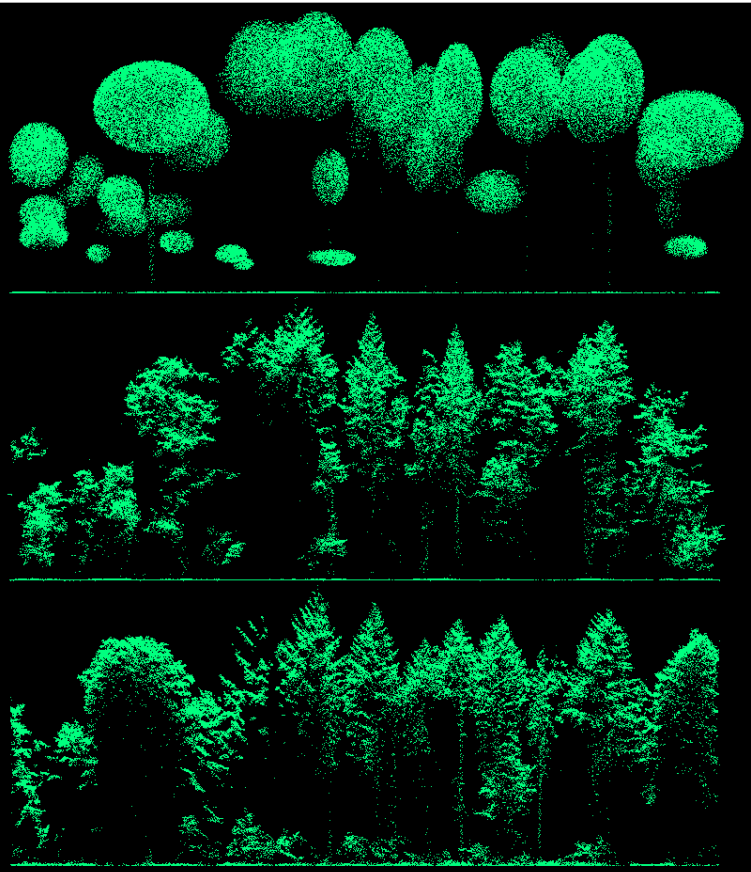
Cross sections



simulated RTM data

original ALS data

Cross sections

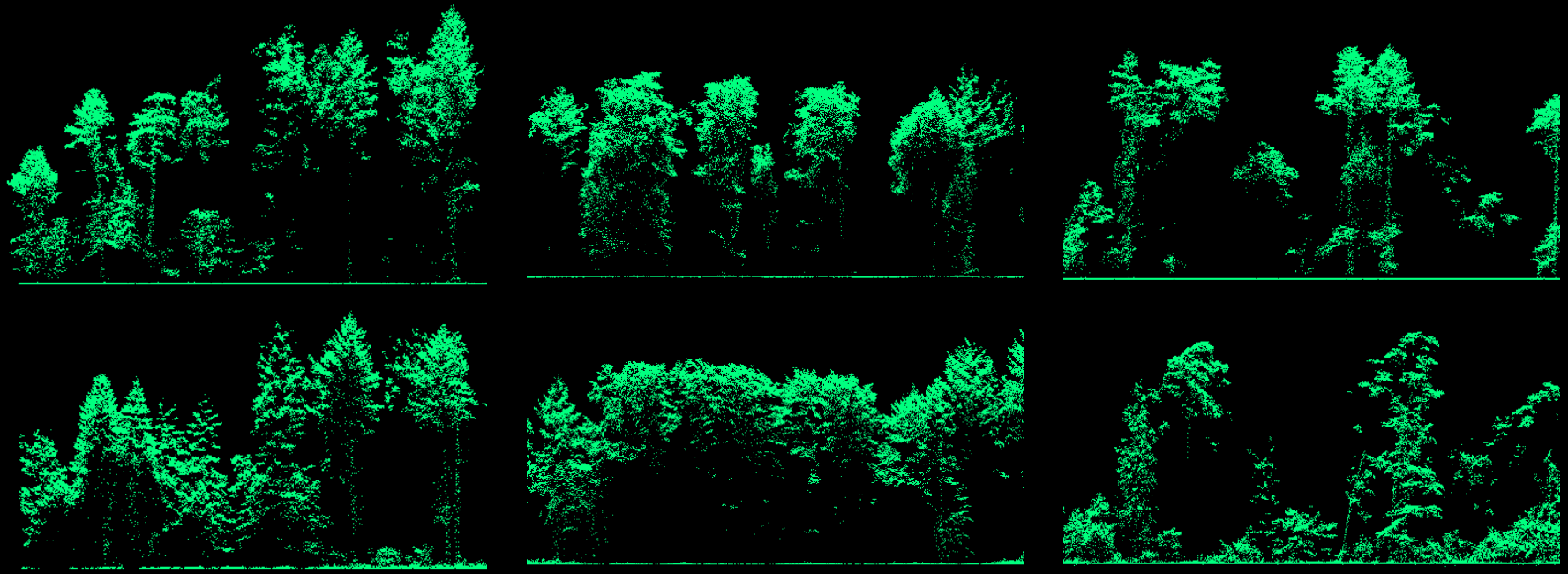


simulated STM data

simulated RTM data

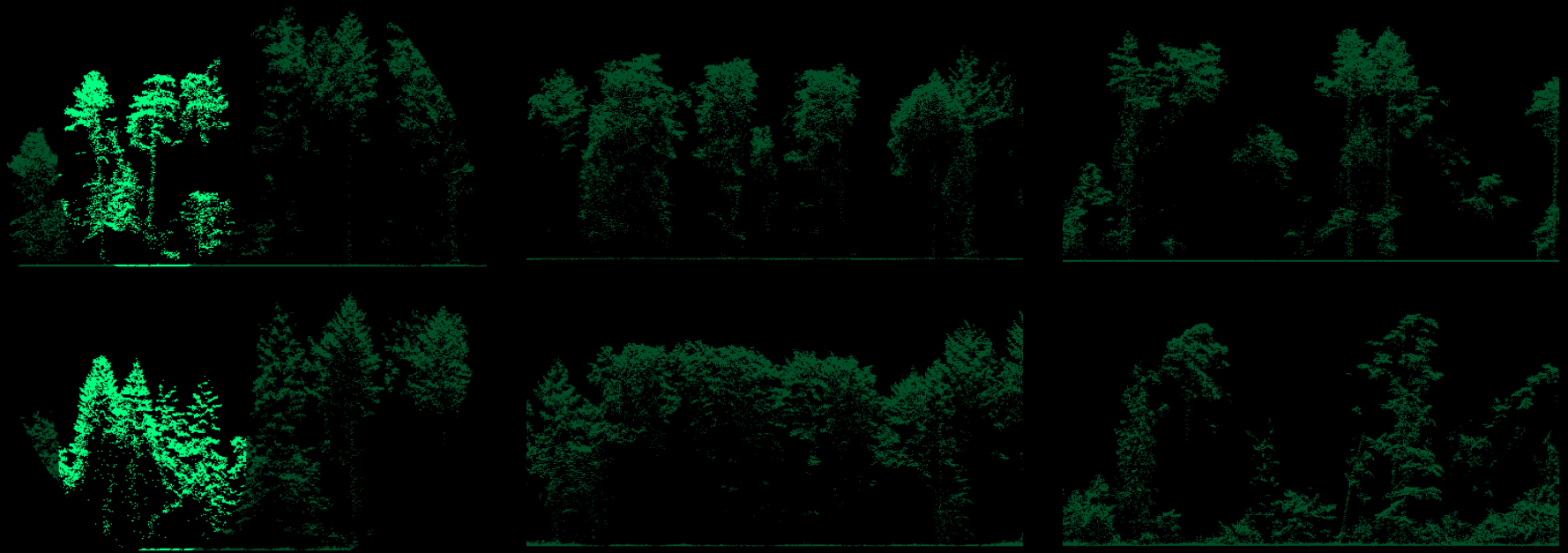
original ALS data

Cross sections – revealed problems of synthetic stands



Cross sections – revealed problems of synthetic stands

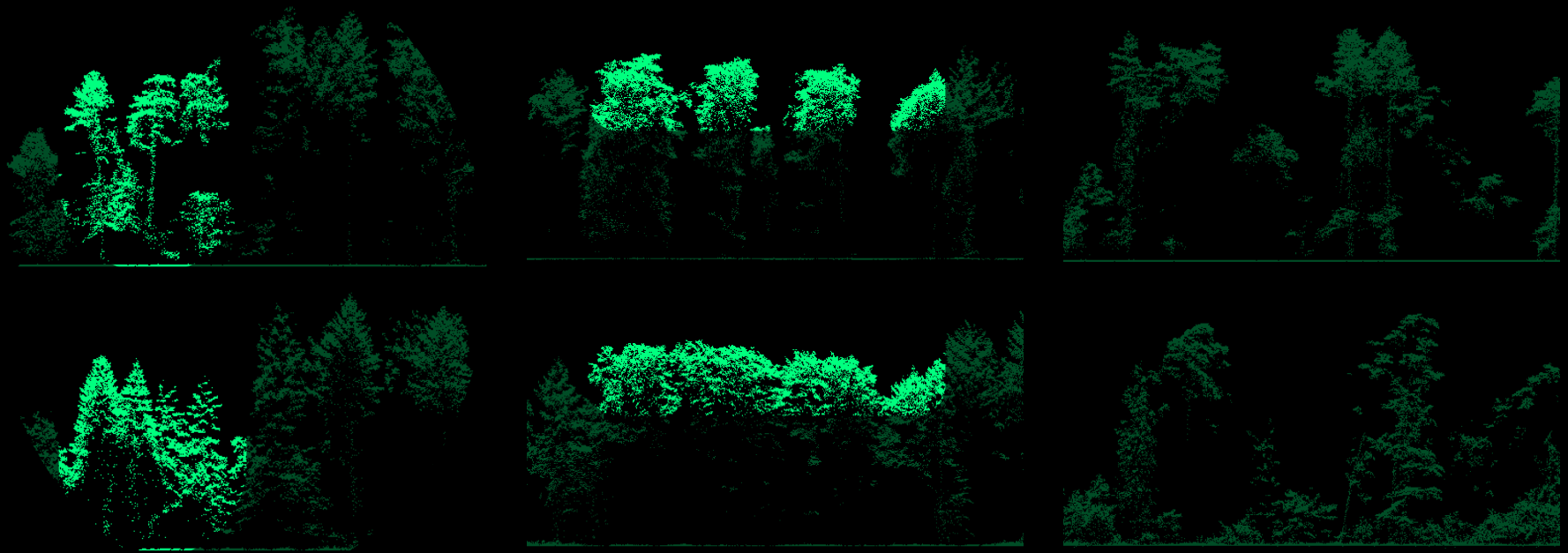
false tree model species



Cross sections – revealed problems of synthetic stands

false tree model species

canopy gaps

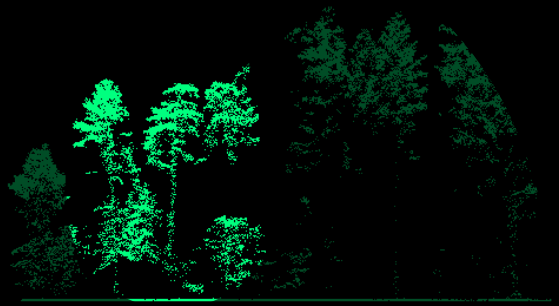


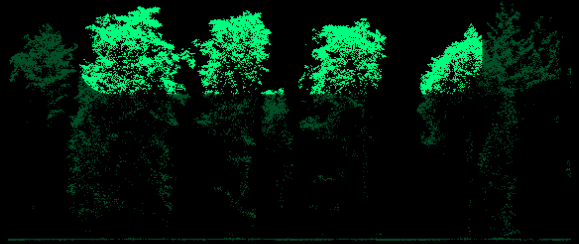
Cross sections – revealed problems of synthetic stands

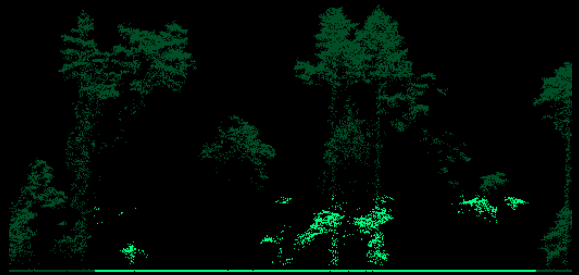
false tree model species

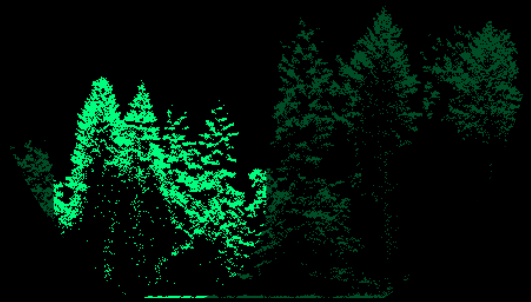
canopy gaps

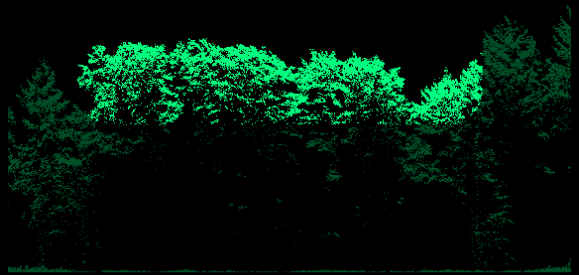
missing undergrowth

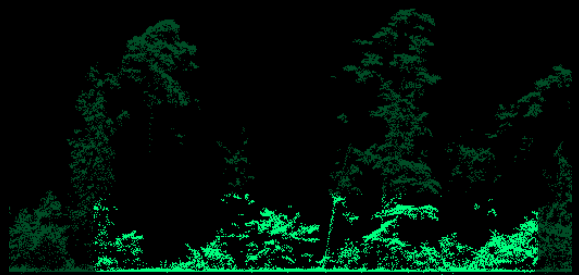








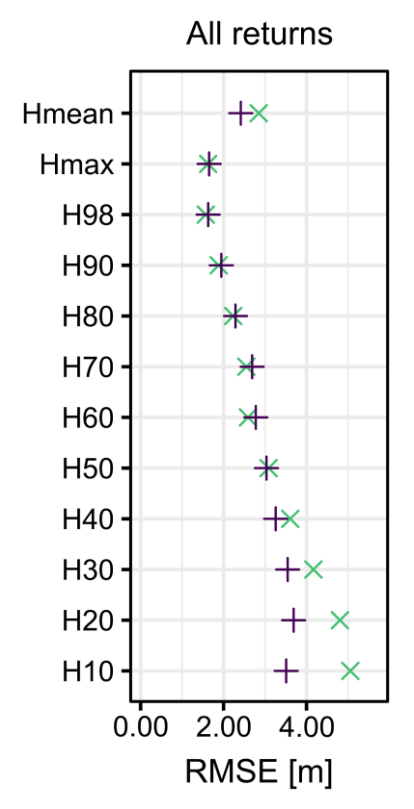


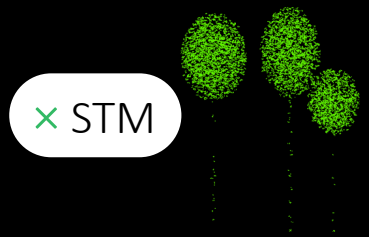


Height percentiles

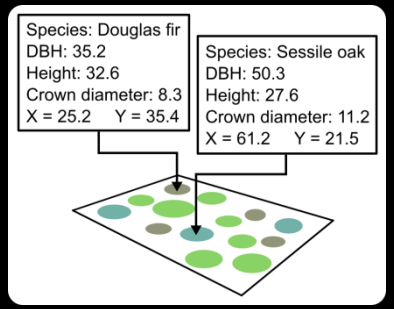
20 m × 20 m

Height percentiles





Conclusion

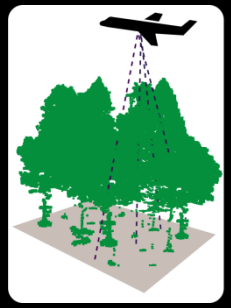


forest inventory information

+

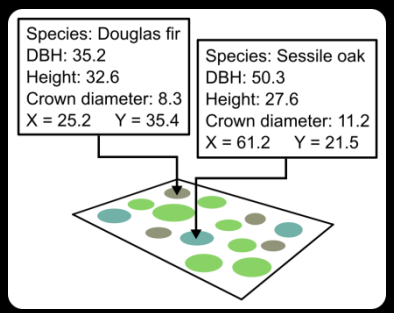
tree point cloud database

+



HELIOS++

Conclusion



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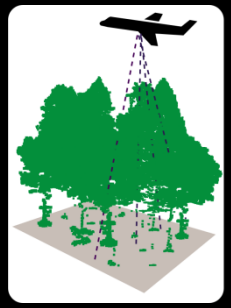
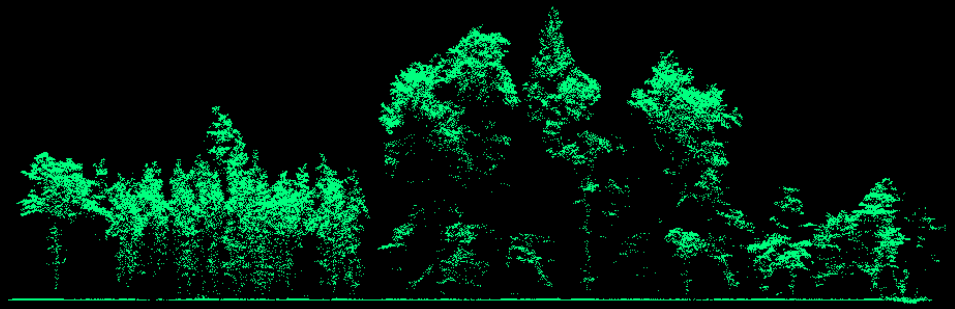


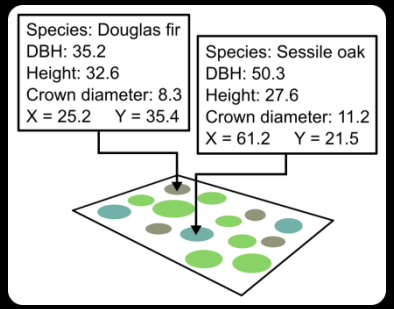
forest inventory information

tree point cloud database

HELIOS++

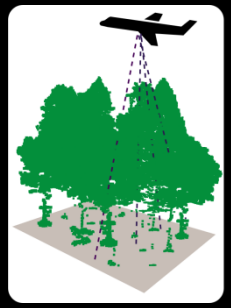


Conclusion

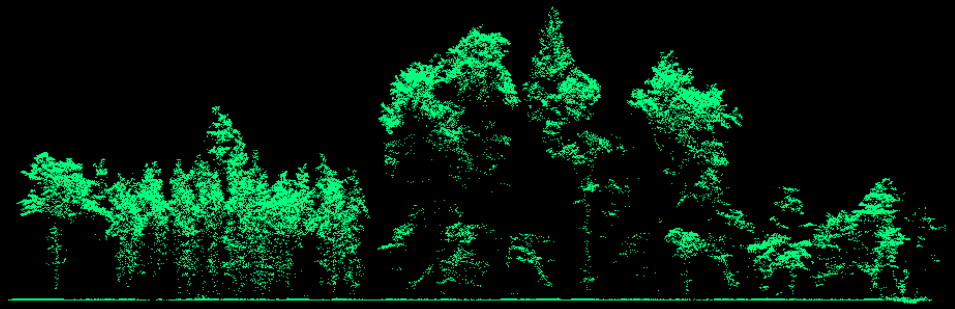


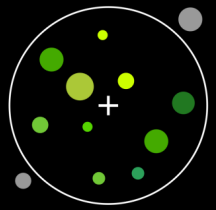
forest inventory information

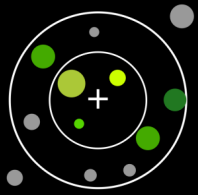
tree point cloud database

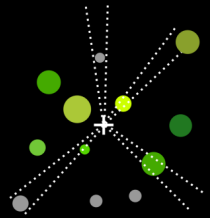


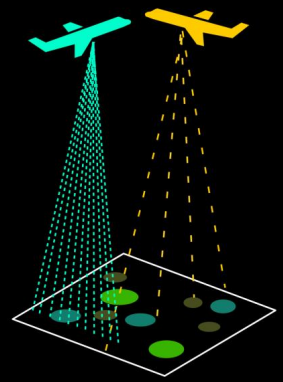
HELIOS++

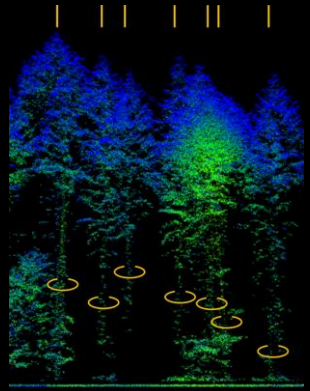












Thank you for your attention!

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More information:

uni-heidelberg.de/syssifoss

uni-heidelberg.de/helios

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Links and references

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