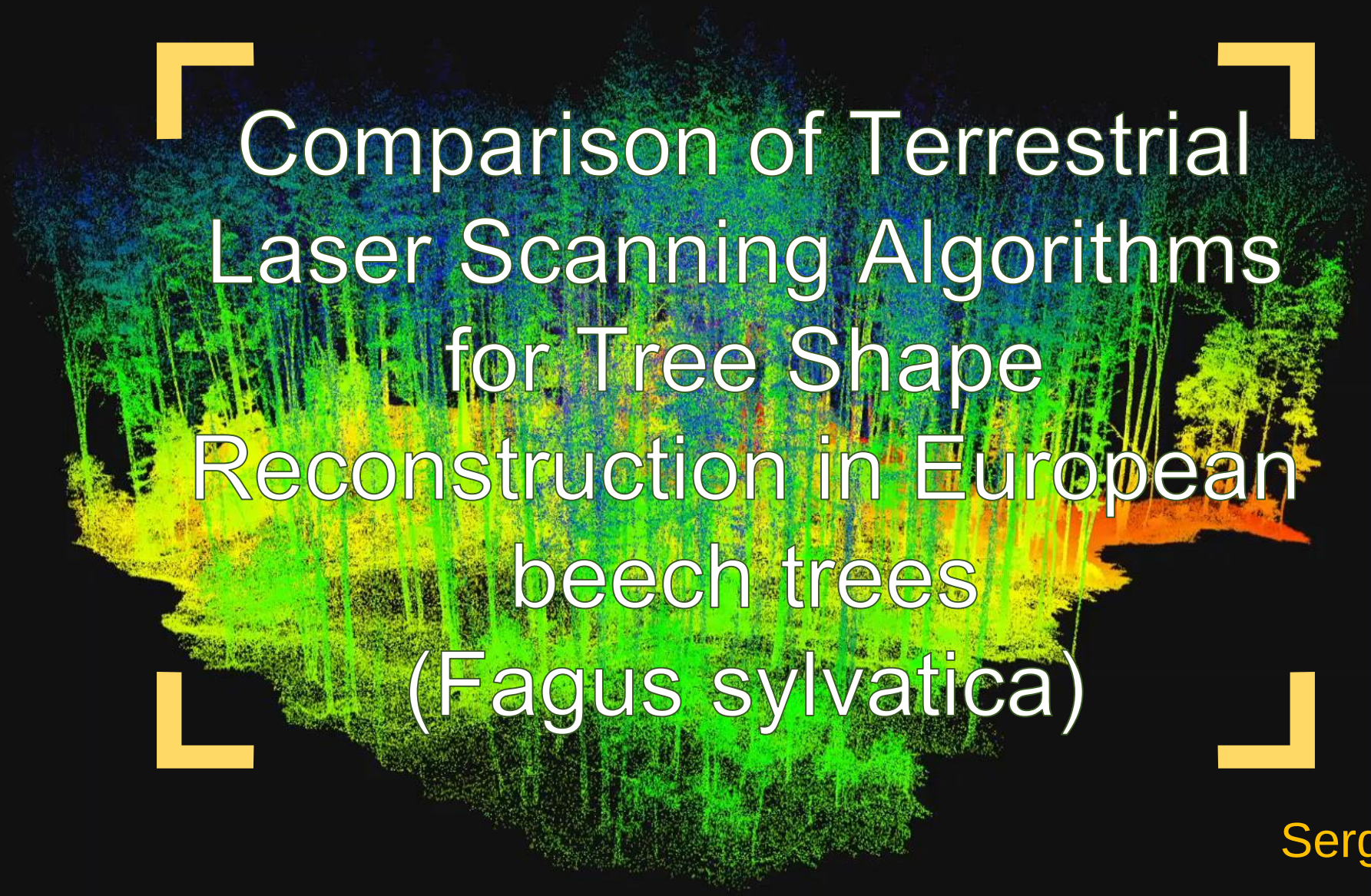


Comparison of Terrestrial Laser Scanning Algorithms for Tree Shape Reconstruction in European beech trees (Fagus sylvatica)

Sergiu Florea

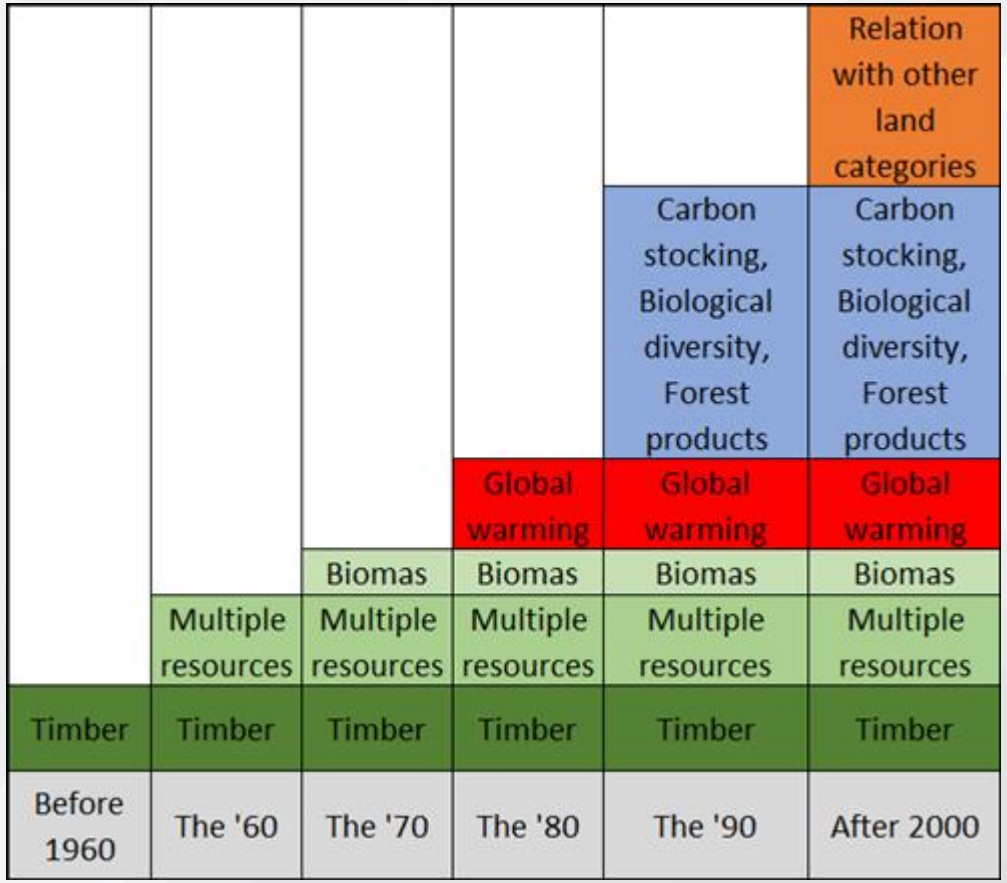
Logical thread

1. Introduction
2. Methods
3. Results
4. Conclusion

01 Introduction

Why?

•**Purpose**: To compare different algorithms used in terrestrial laser scanning (TLS) for reconstructing tree shapes.



Forest polifunctionality

Largest carbon reservoir

Fresh water source

Renewable resource – timber, firewood

Multiple species habitat – flora & fauna

Extreme weather regulator

Hunting and fishing

Protector of soil

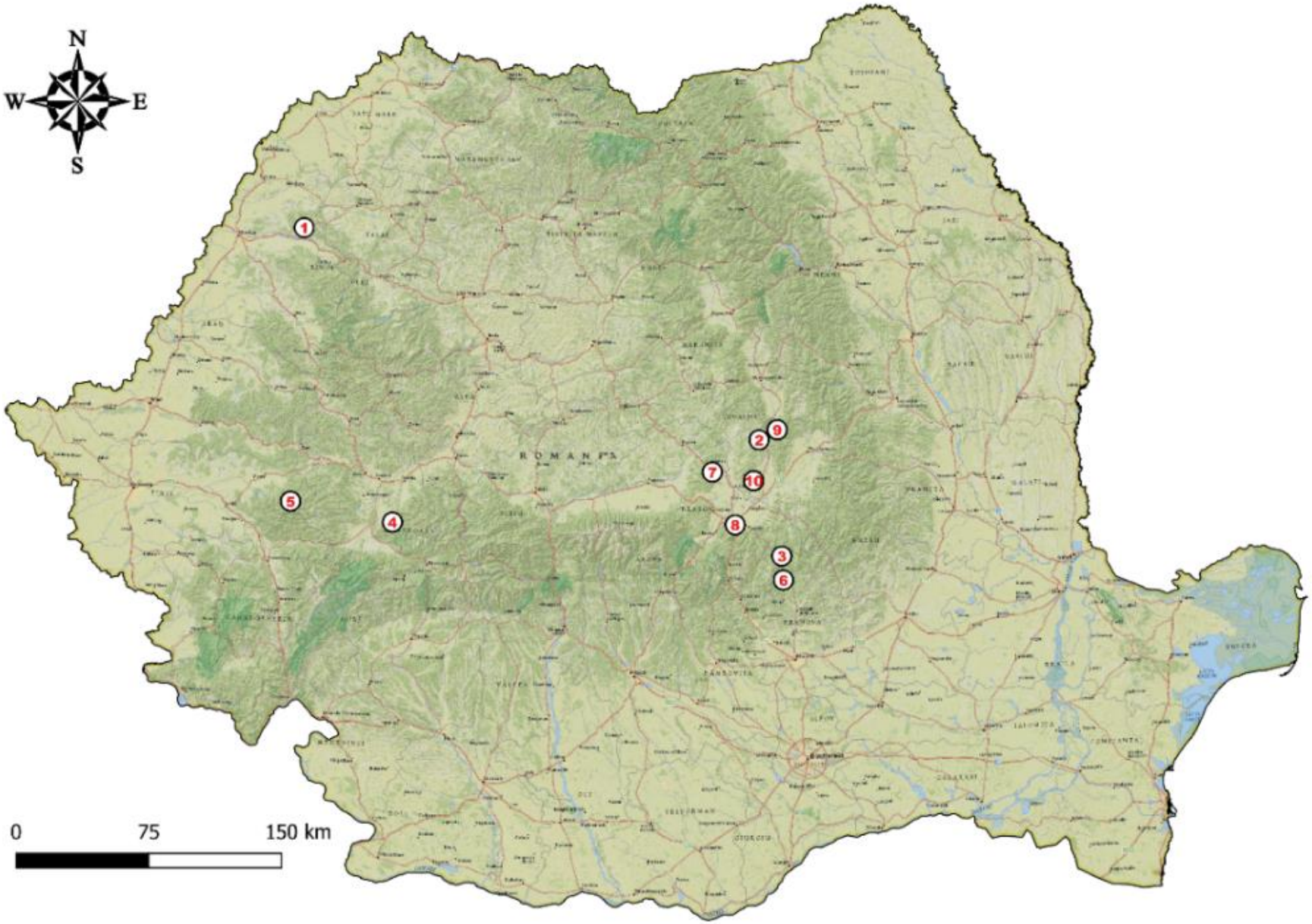
Medicinal herbs

02 Methods

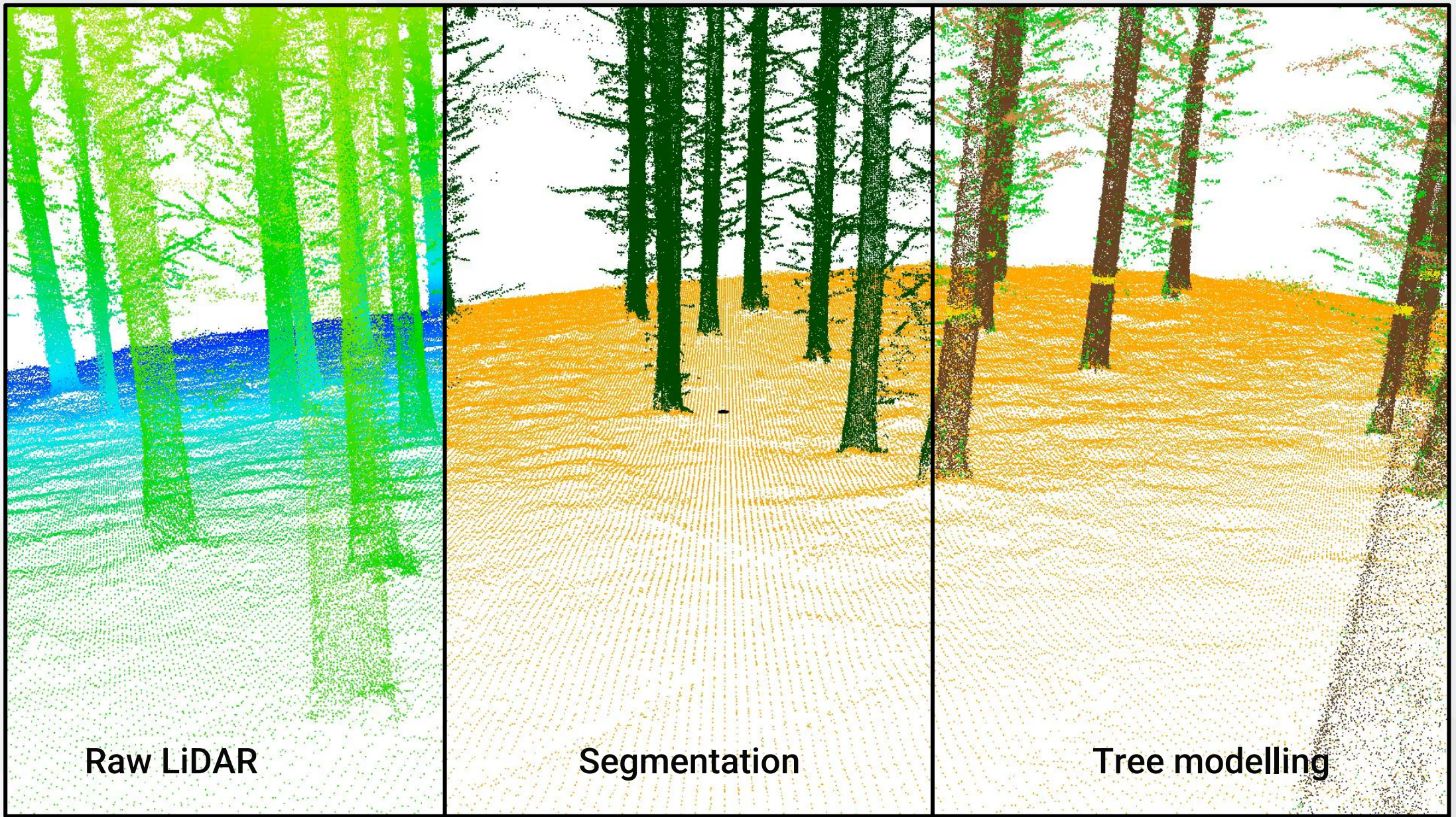
How?

Data collection

FARO Focus S70



02 Methods



02 Methods

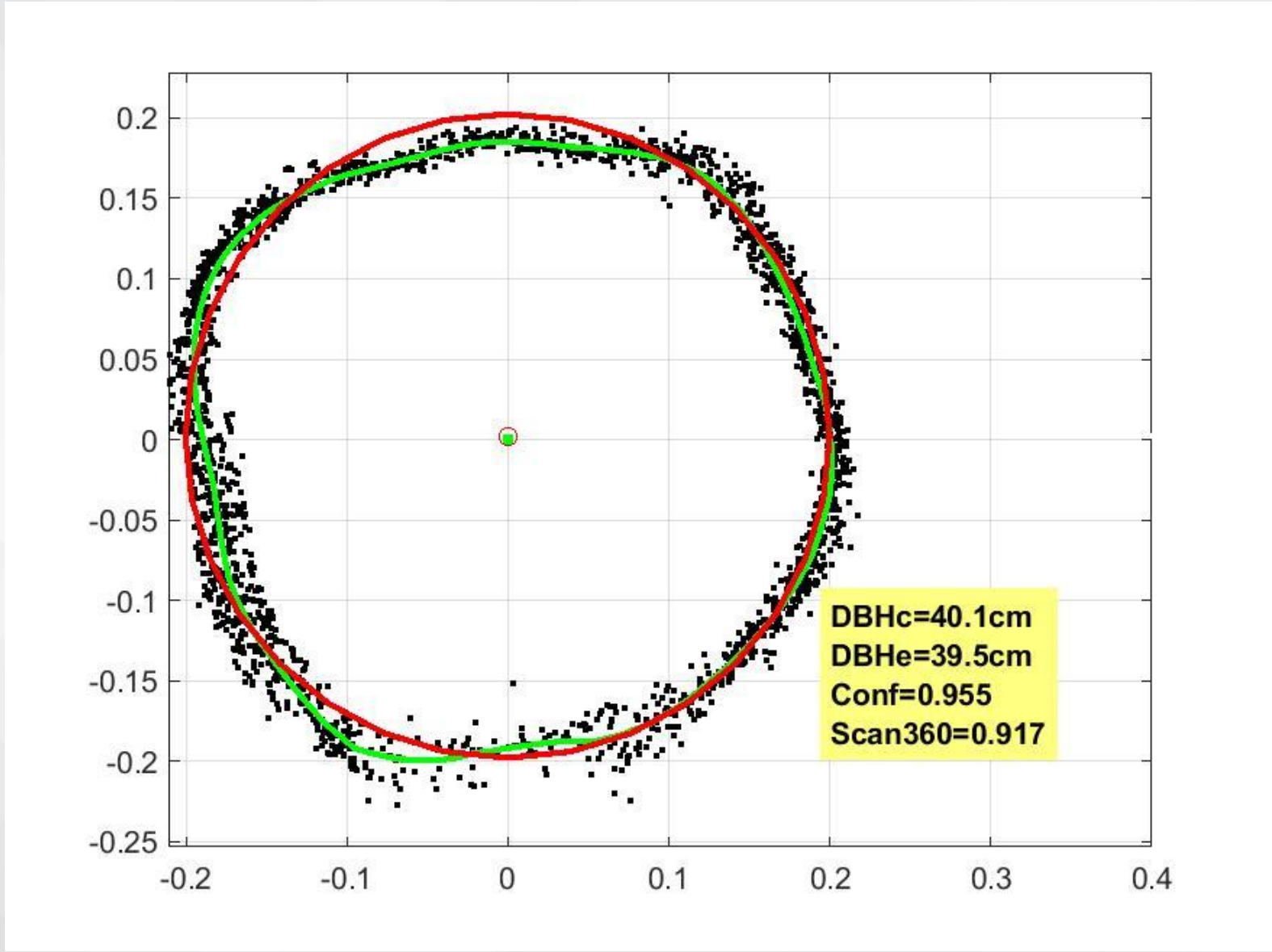
Method	Tree attribute			
	DBH	H	Stem volume	Aboveground tree volume
CloudCompare reconstruction methods				
Poisson	no	no	yes	no
RANSAC	no	no	yes	no
QSM algorithms				
TreeQSM MATLAB	yes	yes	yes	yes
3D Forest	yes	yes	no	yes

- Algorithms Compared: CloudCompare: **Poisson Surface Reconstruction** and **RANSAC (Random sample consensus)**
- **TreeQSM:** MATLAB-based quantitative structure modeling
- **3D Forest:** Open-source software for tree structure analysis

03 Results

DBH Estimation

- **DBH1** – 3DForest, Randomized Hough Transformation (RHT), circle fitting (most frequent circle)
- **DBH2** - 3DForest, Least Squares Regression (LSR), circle fitting (minimizing distance between circle and points)
- **DBH3** –3DForest, DBH cloud, circle fitting (inside the point-cloud)
- **DBH4** –TreeQSM algorithm, mean stem diameter between 1.1 and 1.5 m
- **DBH5** –TreeQSM, stem at 1.3 meters, fitted cylinders

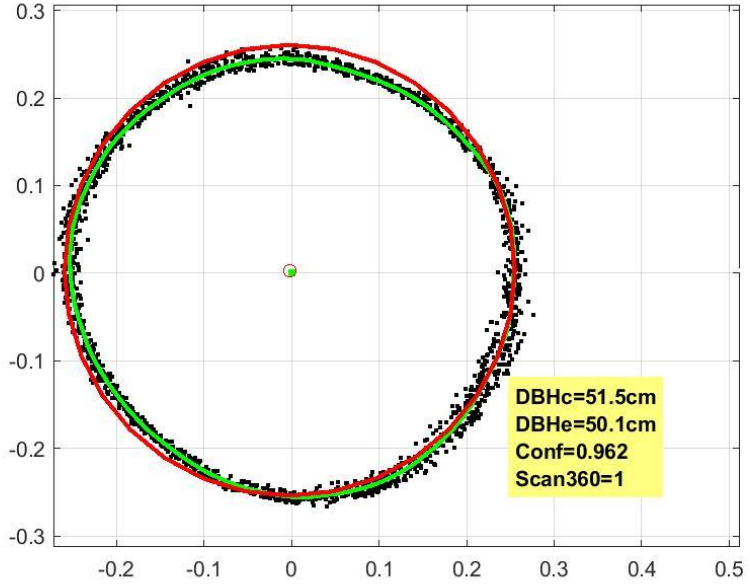


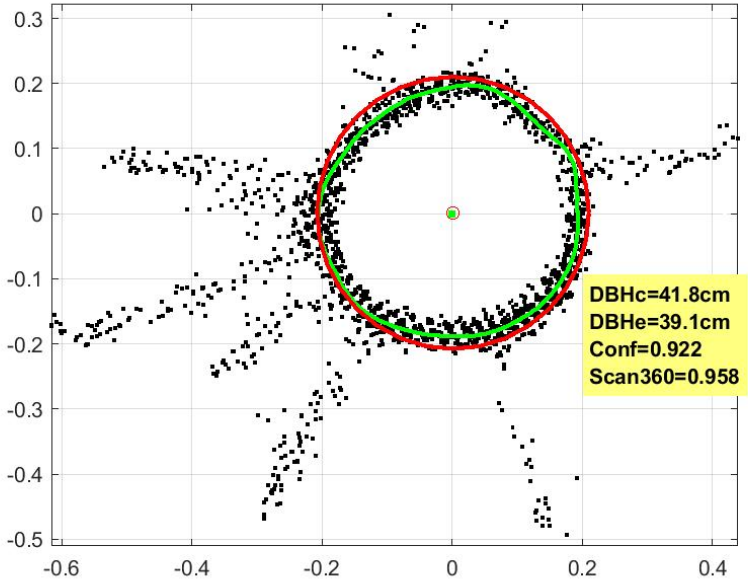
03 Results

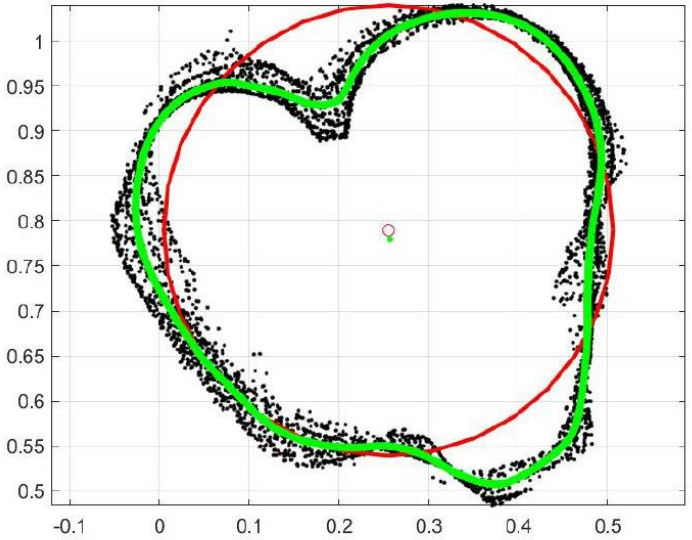
DBH Estimation

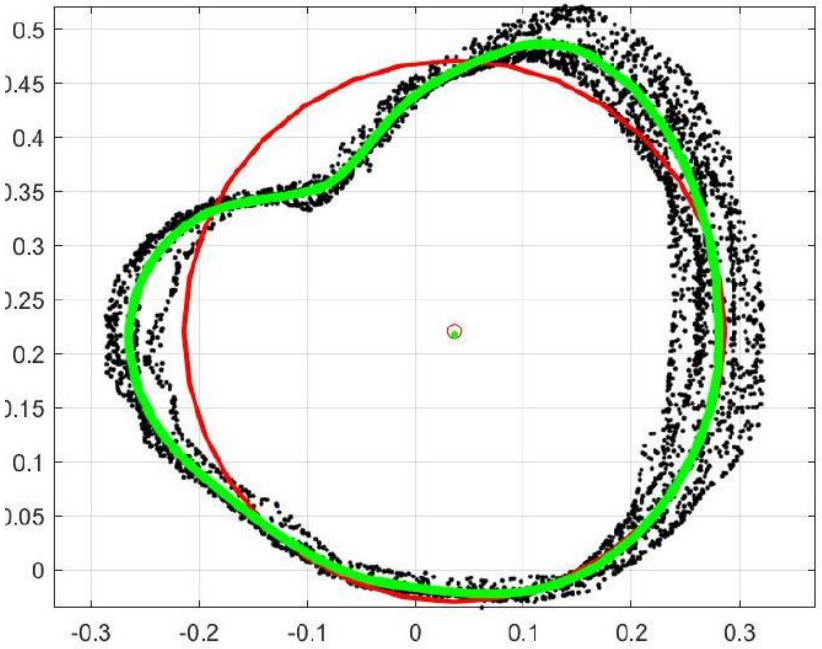
Findings:

- High agreement among DBH1, DBH2, DBH4, and DBH5.
- Significant discrepancies with DBH3.
- Variability increases with tree size.
- The largest differences were observed for trees with large DBH.





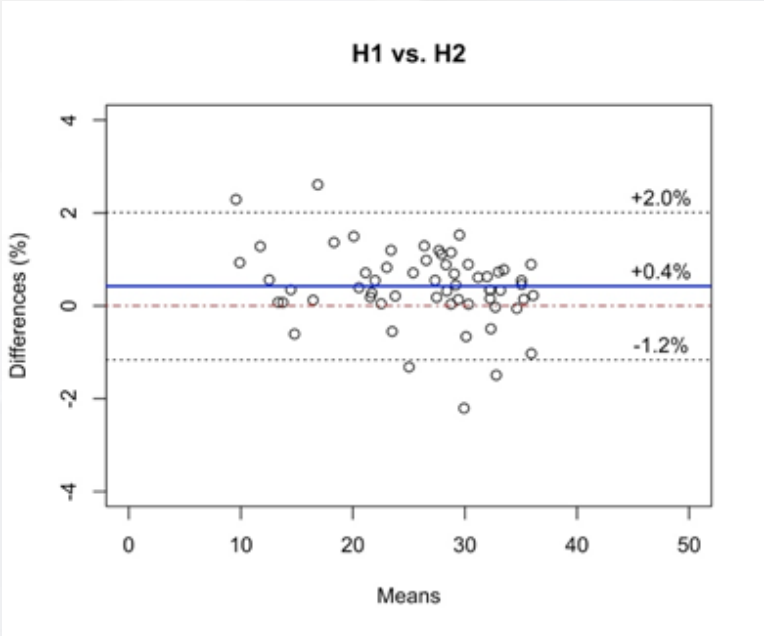




03 Results

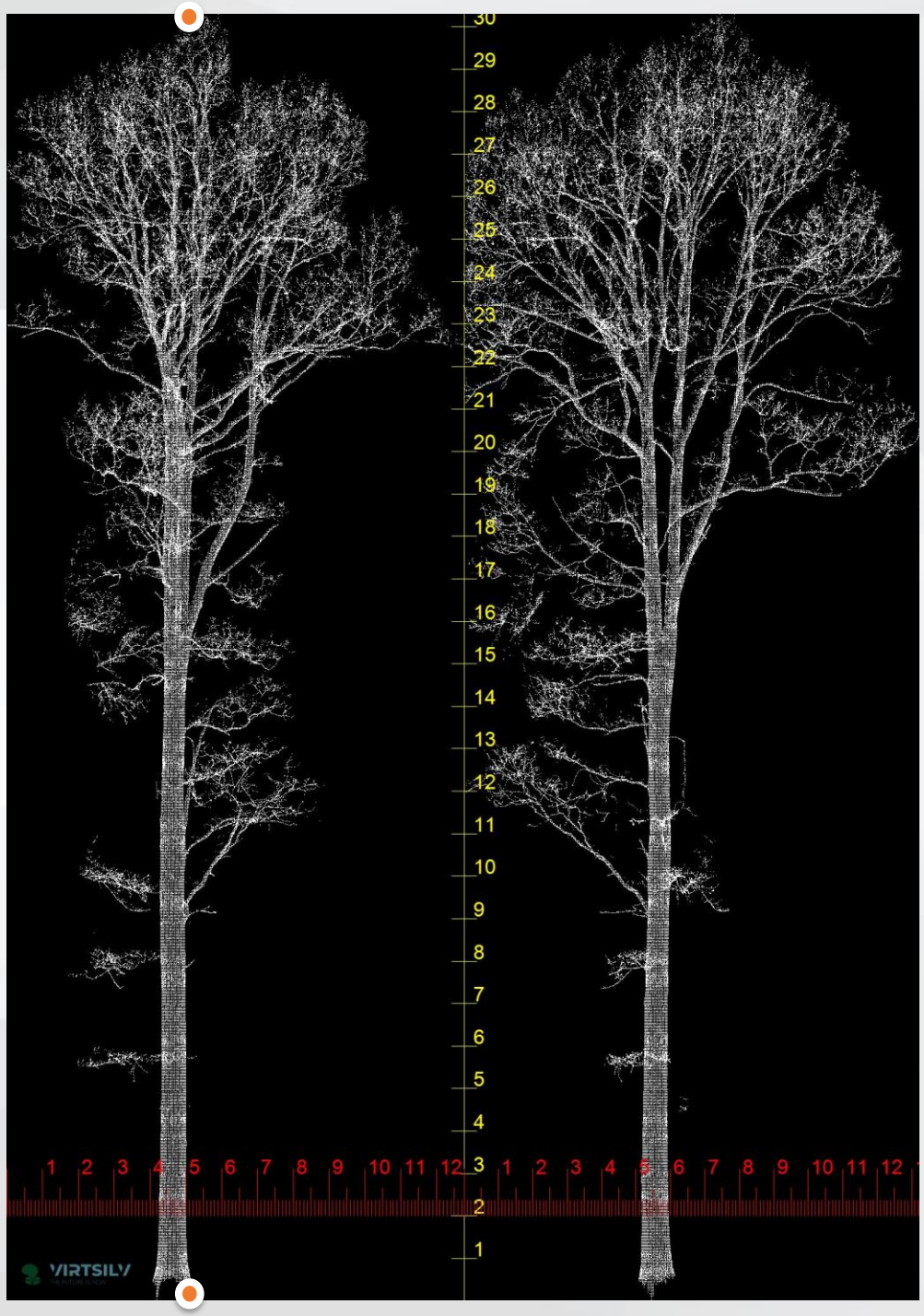
H Estimation

Comparison: H1 (3DForest) vs. H2 (TreeQSM).



Findings:

- Relatively consistent with a mean difference of 0.31m.
- Differences increase with tree height, especially for trees >20m.

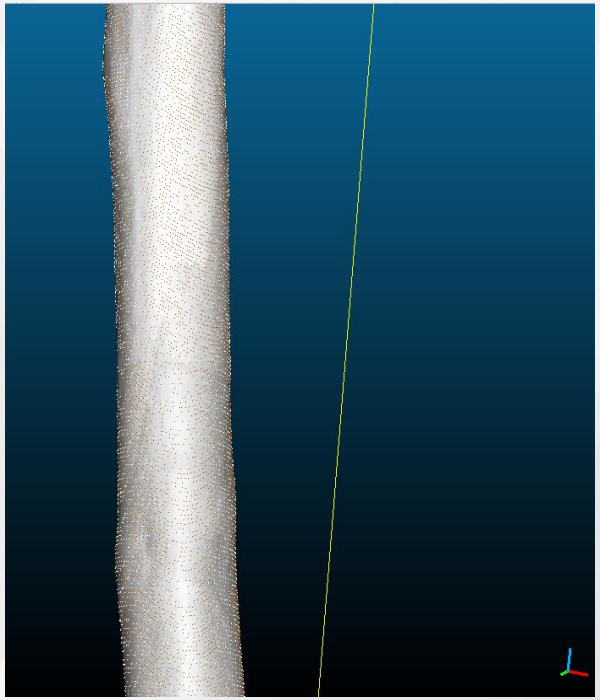


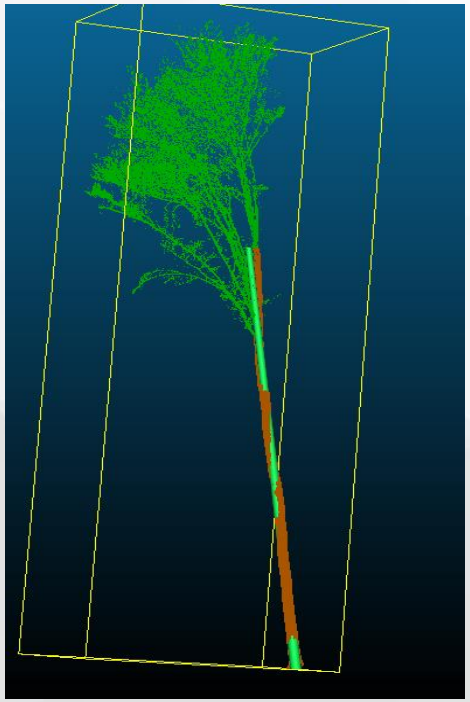
03 Results

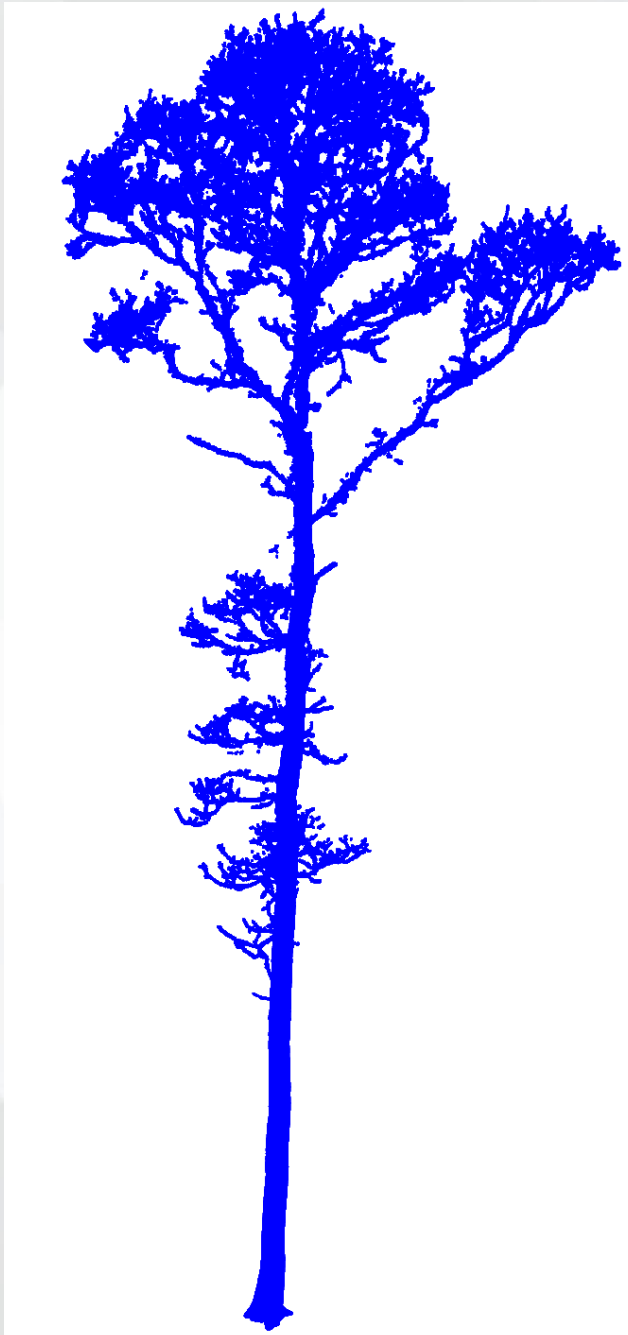
Stem volume Estimation

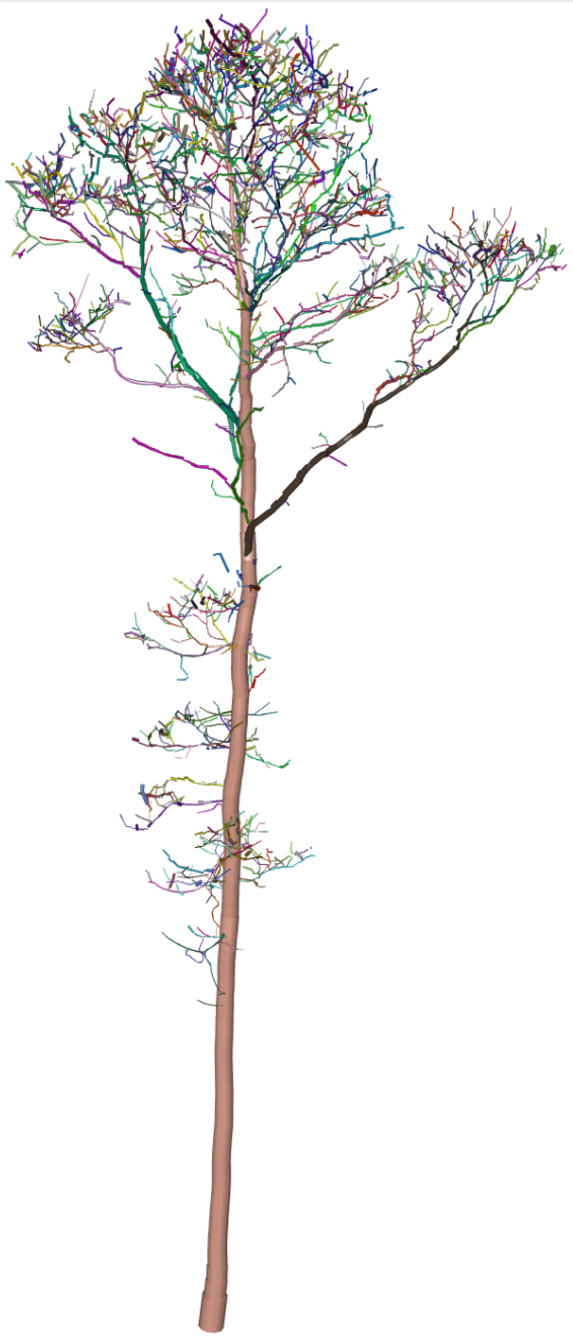
Comparison:

- Vst1 (TreeQSM), sum of all stem cylinders
- Vst2 (RANSAC), fits the tree into a cone
- Vst3 (Poisson), fits the tree into a mesh







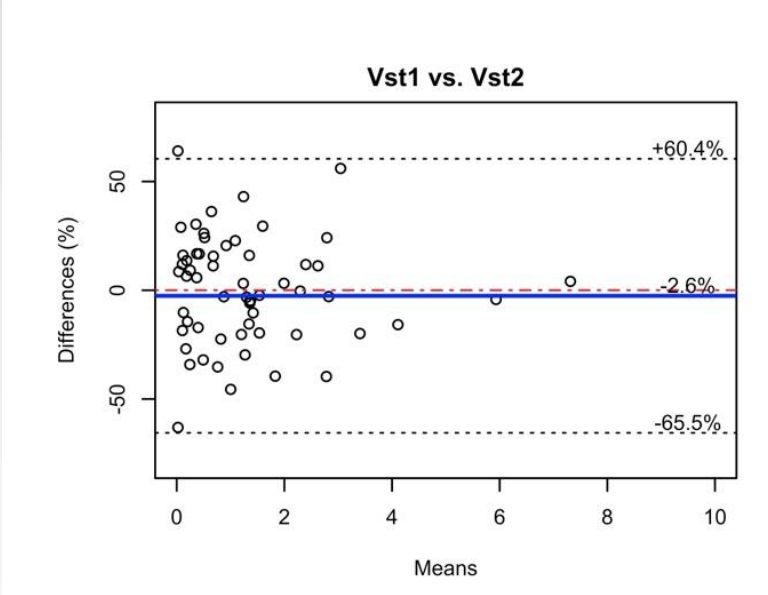


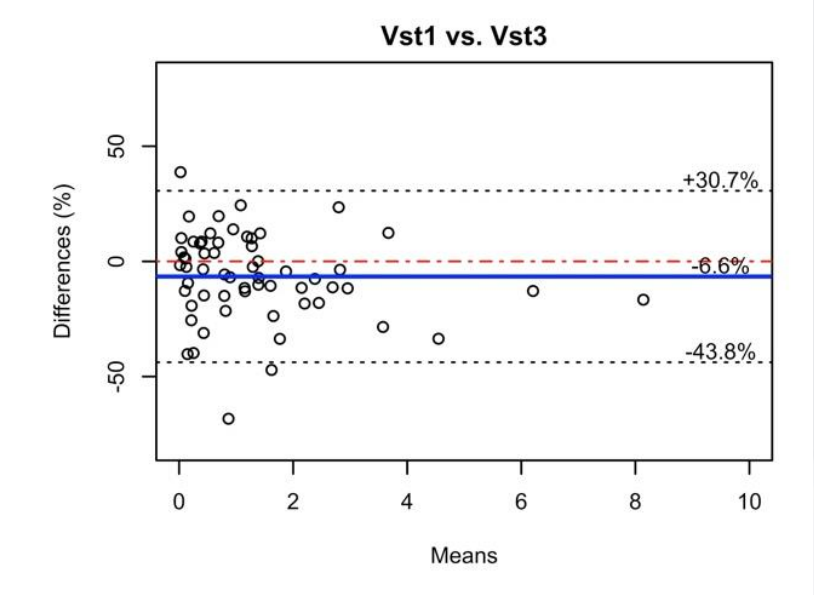
03 Results

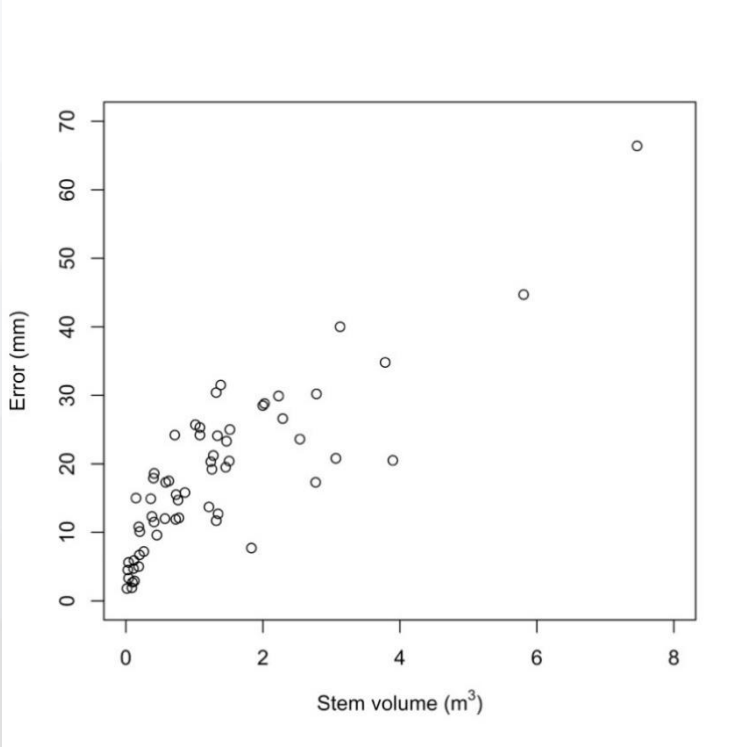
Stem volume Estimation

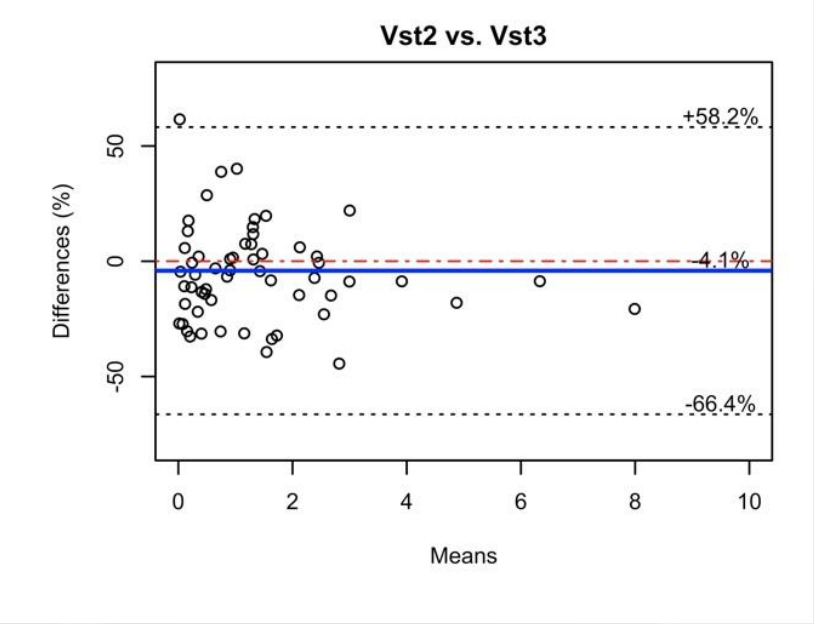
Findings:

- Poisson method tends to overestimate volume.
- RANSAC shows better agreement with TreeQSM.
- Errors increase with tree size.









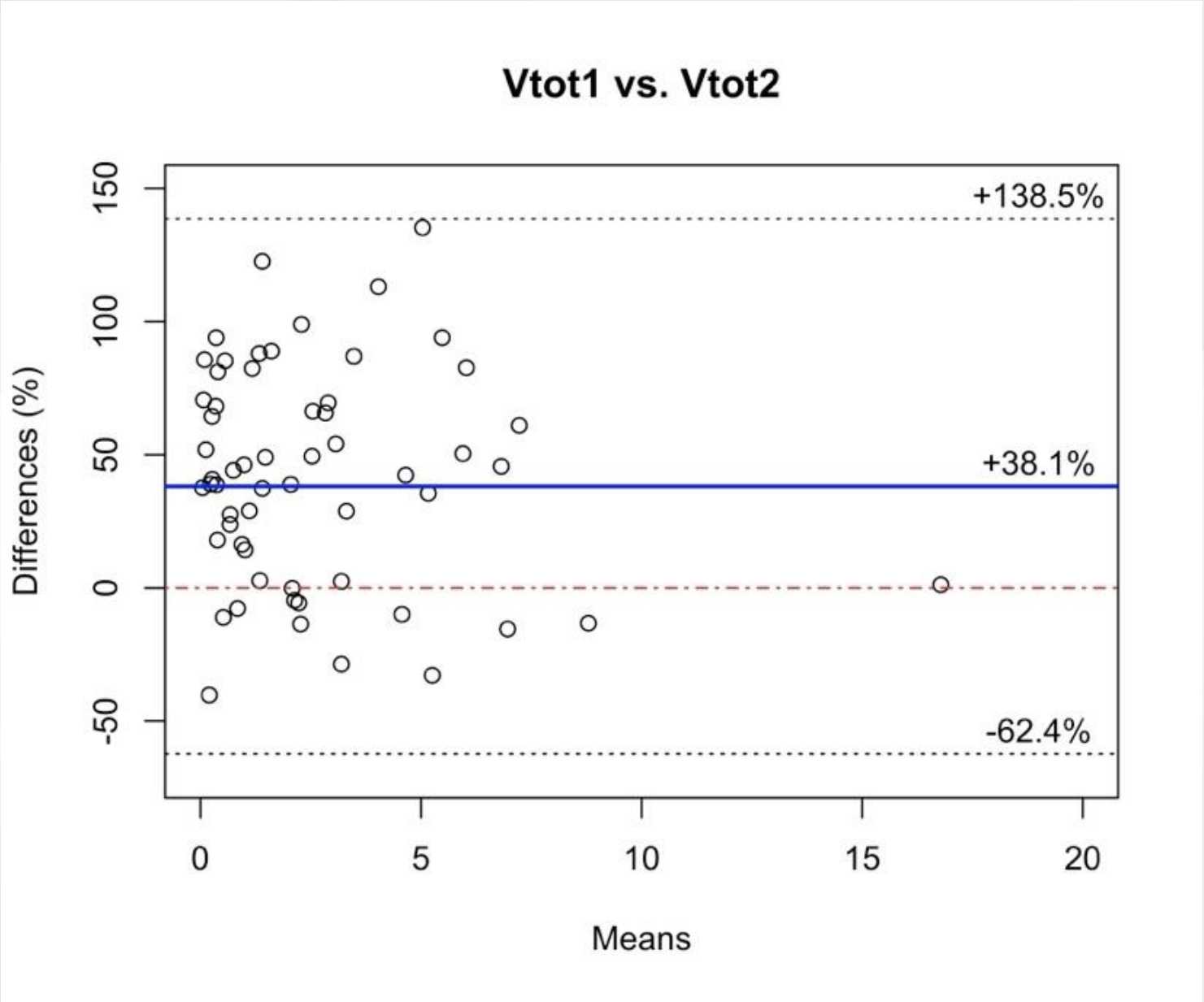
03 Results

Total volume Estimation

Comparison: Vtot1 (3DForest) vs. Vtot2 (TreeQSM)

Findings:

- 3DForest systematically produces larger estimates.
- Differences increase with tree size.
- Largest discrepancy observed was 6.9 m^3.



04 Conclusions

- **DBH Measurement**: Cylinder fitting methods (TreeQSM) provide more precise measurements.
- **Height Measurement**: 3DForest tends to overestimate height.
- **Stem Volume Measurement**: TreeQSM and RANSAC methods are more reliable.
- **Total Volume: TreeQSM** produced the fewest abnormalities in crown reconstruction, resulting in the best volume estimation

•**Key Takeaways**:

- Significant differences exist between algorithms.
- Visual inspection is crucial to detect and correct reconstruction errors.
- TreeQSM is recommended as the most reliable method for tree reconstruction.


Thank you for your attention!
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