Extraction of temporal plant information using 3D LiDAR data in apple trees

Nikos Tsoulias

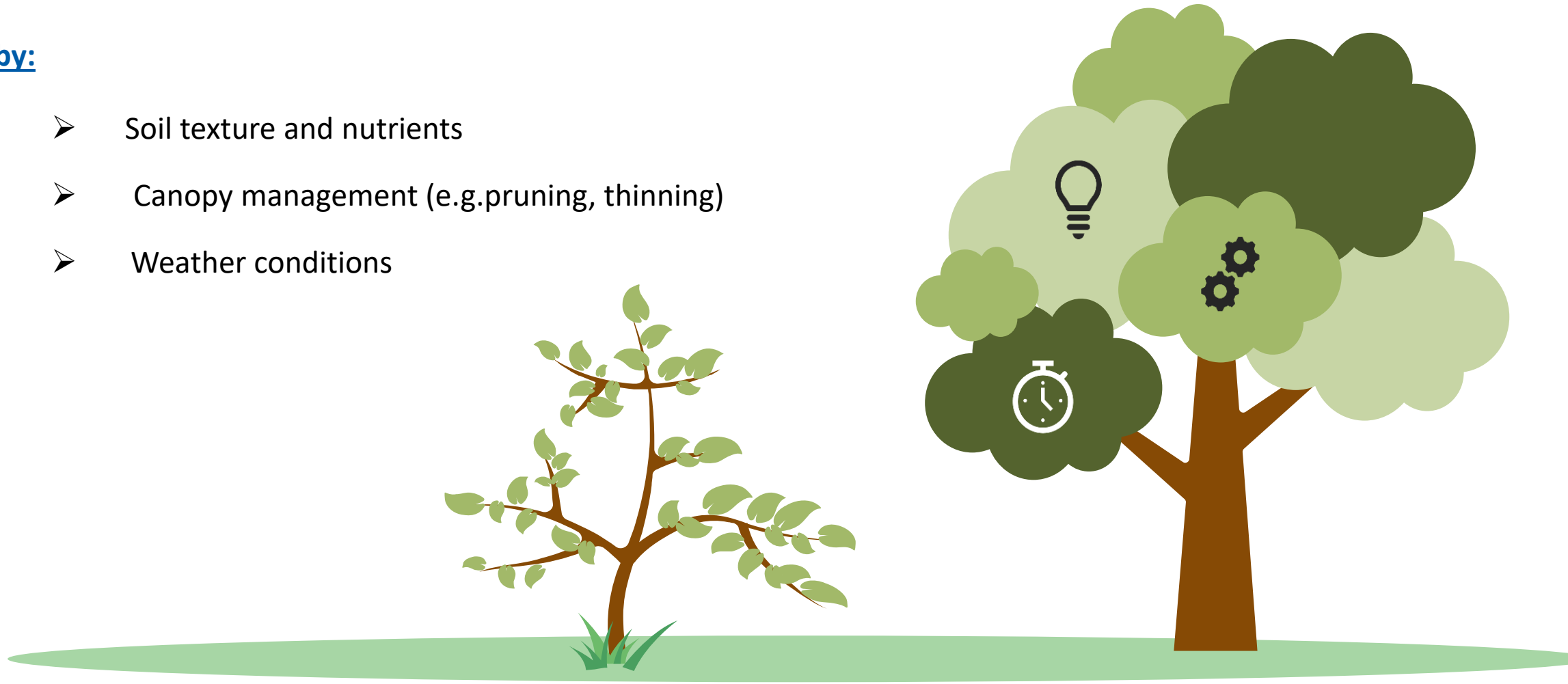
ATB
Leibniz-Institut für
Agrartechnik und Bioökonomie

Impact in:

- Evapotranspiration
- CO_2 assimilation
- Crop load and fruit quality

Affected by:

- Soil texture and nutrients
- Canopy management (e.g.pruning, thinning)
- Weather conditions



Manually:

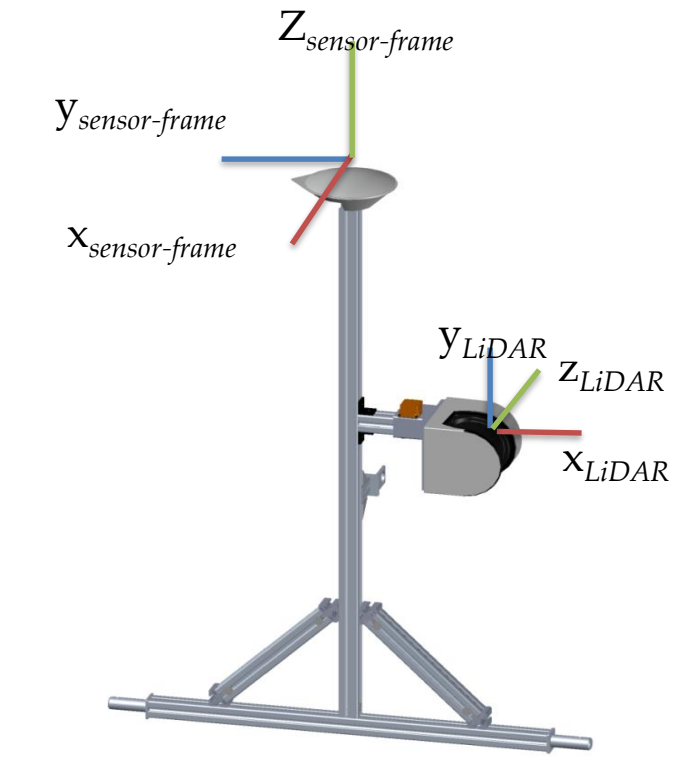
- Time consuming
- Cost-effective (no spatial data)
- Uncertainty (complex data: Volume, Wood structure)

3D Remote sensing techniques :

- Objectiveness
- Repeatable and fast data acquisition
- Larger datasets

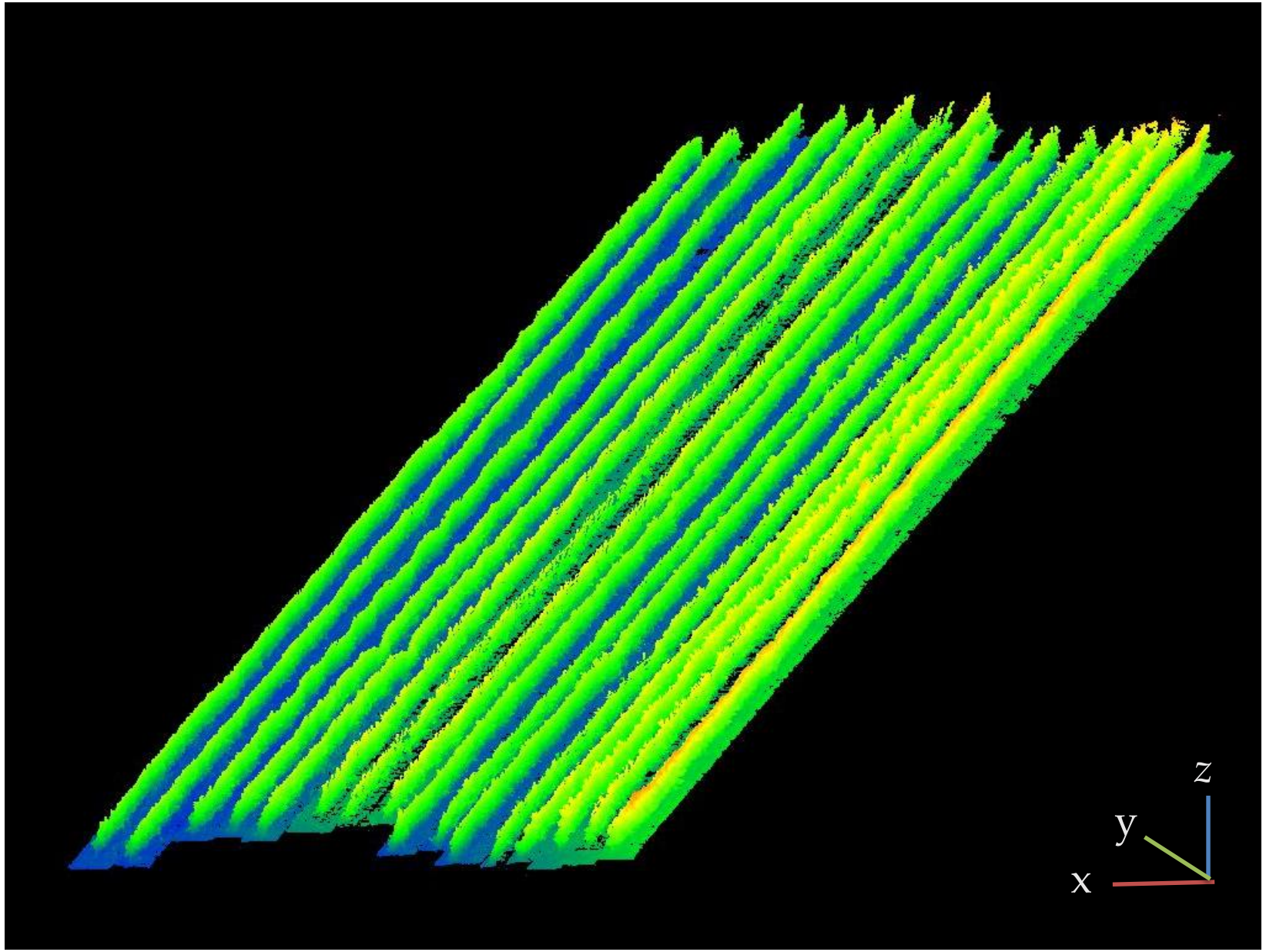
} High resoluted Spatio-temporal data

- Less labour intensive
- Non destructive

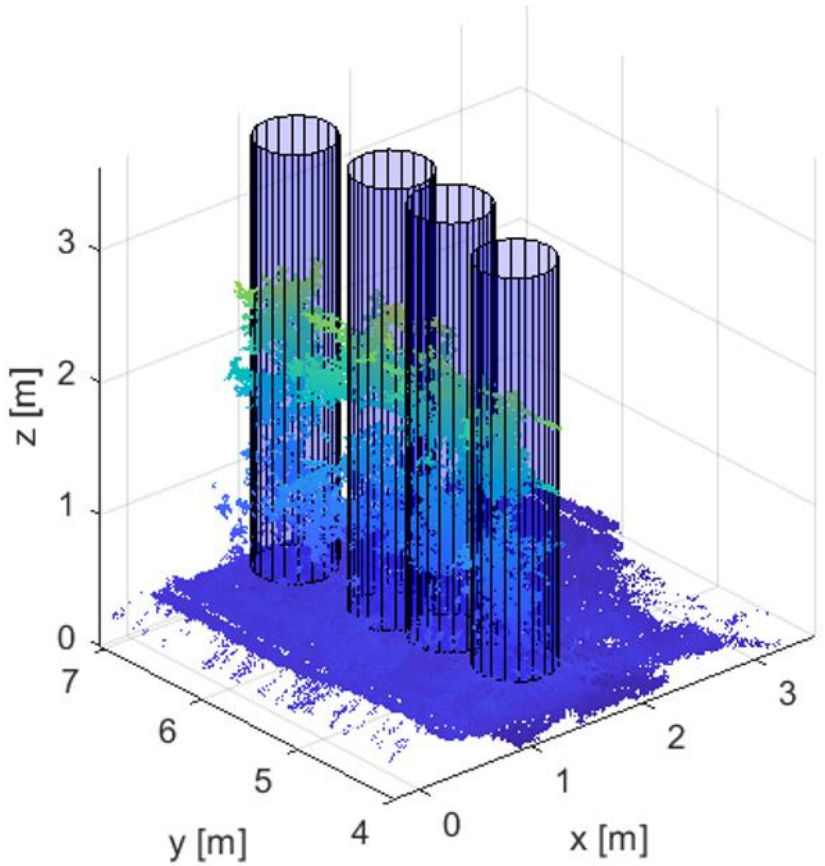


Light detection and range (LiDAR) data :

- High density 3D point clouds
- Backscattered intensity
- The laser beam is not affected by light varying conditions


z
y
x

Determine and segment trees based on their stem position using cylinders



Volume

Leaf area

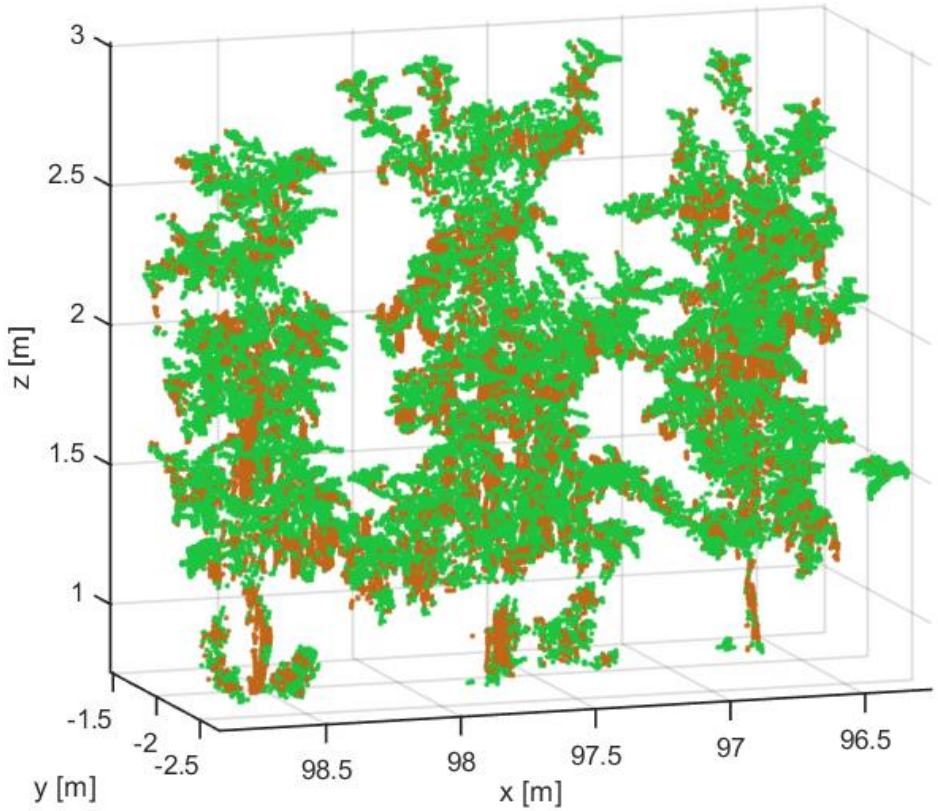
Height, Width

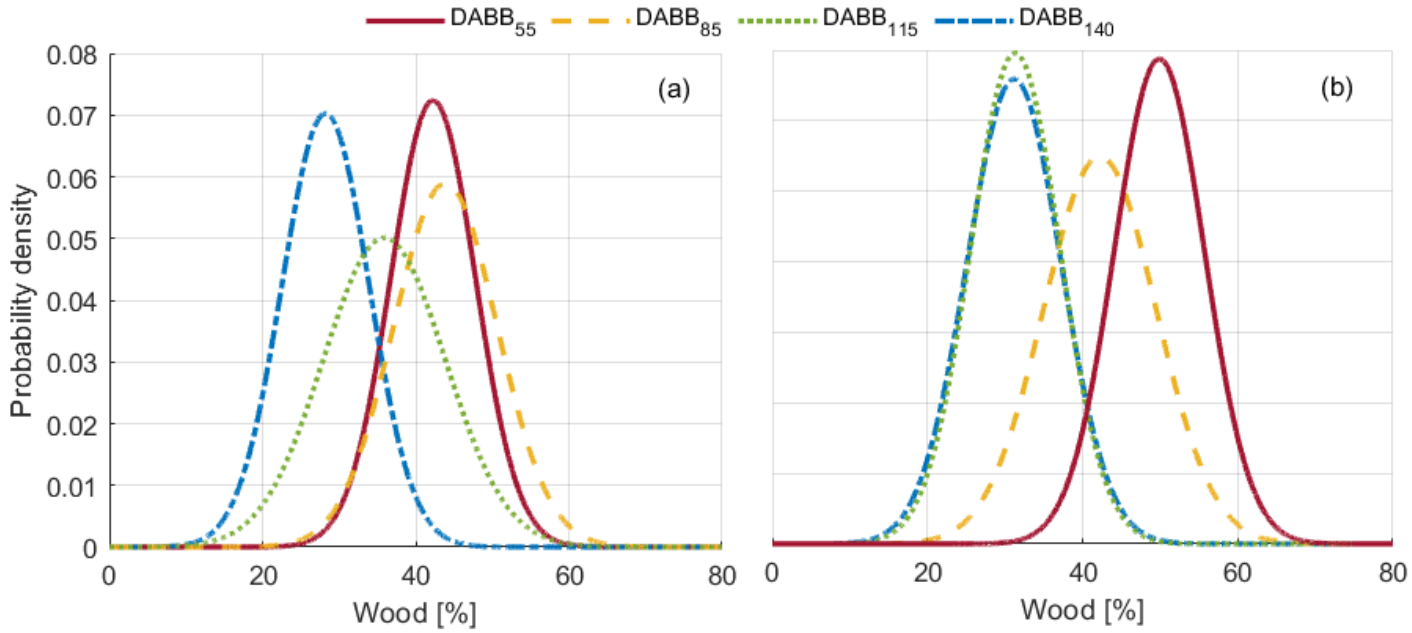
Points per tree

Wood structure

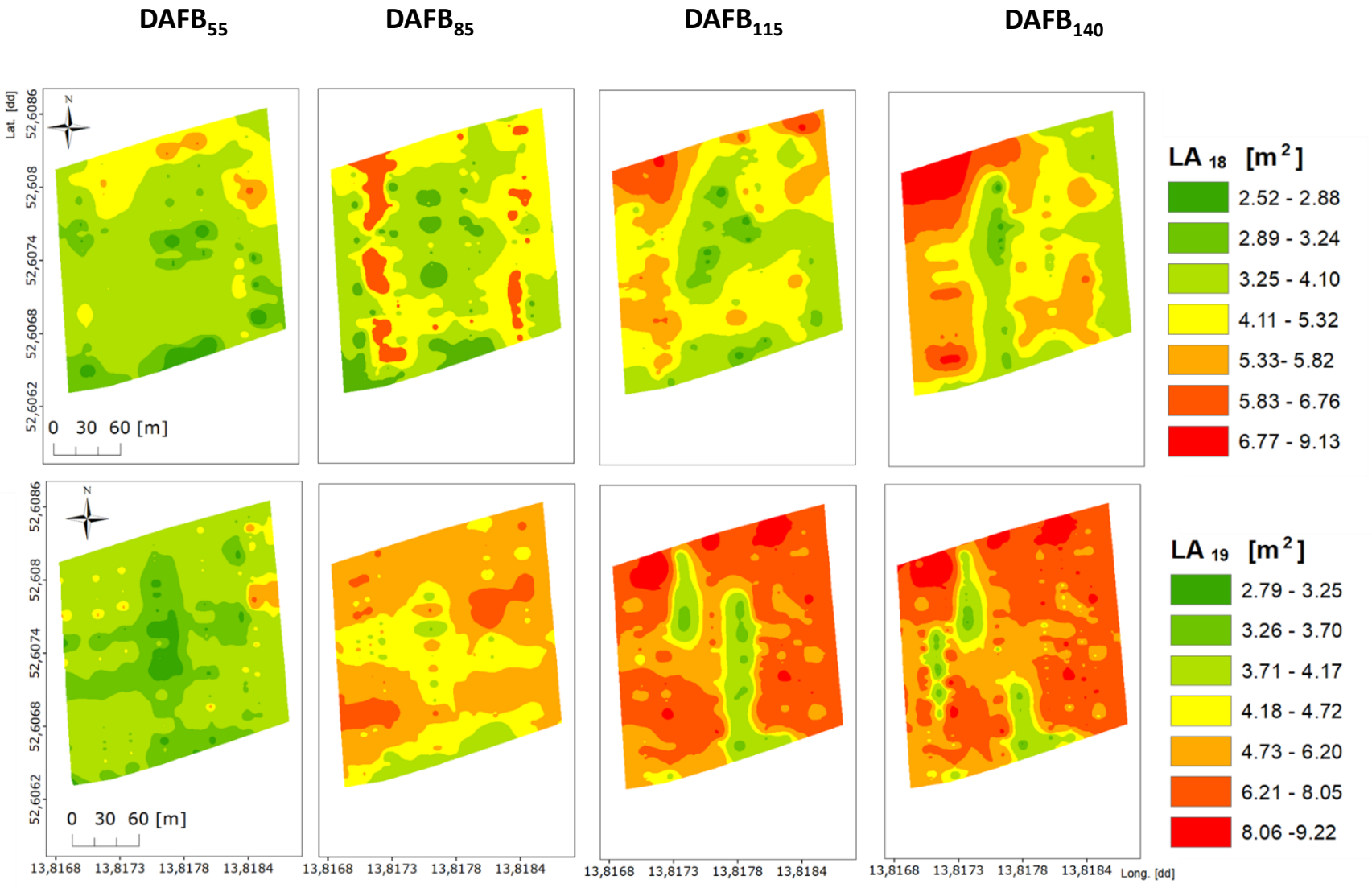
- Extract information per tree
- Increased spatial resolution
- Extract spatio temporal data
- Site specific Management

Tsoulias, N., Paraforos, D. S., Fountas, S., & Zude-Sasse, M. (2019). Estimating Canopy Parameters Based on the Stem Position in Apple Trees Using a 2D LiDAR. *Agronomy*, *9*(11), 740.

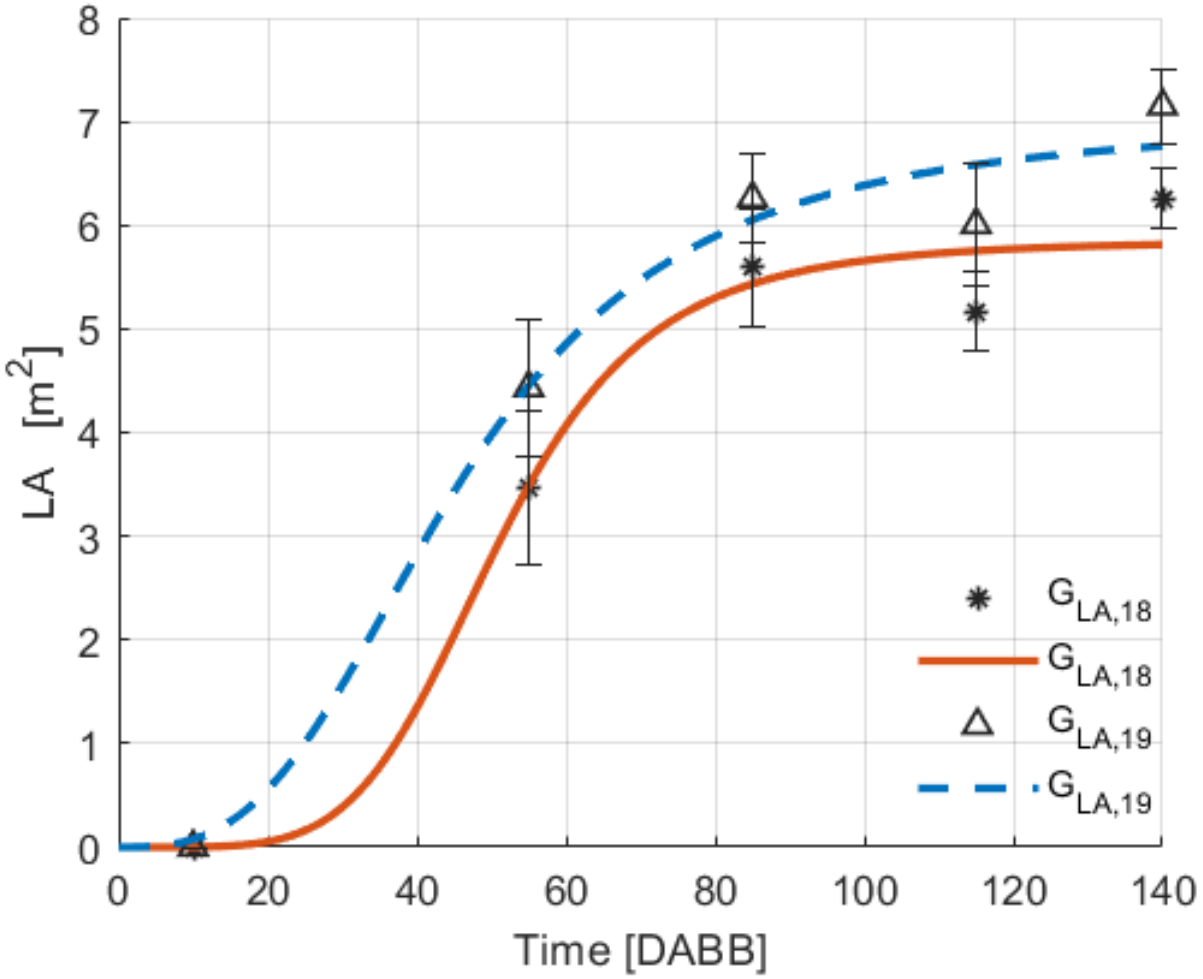




Tsoulias, N., Xanthopoulos G., Fountas S. and Zude-Sasse, M., 2021. Effects of soil ECa and LiDAR-derived leaf area on fruit quality in the apple production. Biosystems Engineering, (In review).

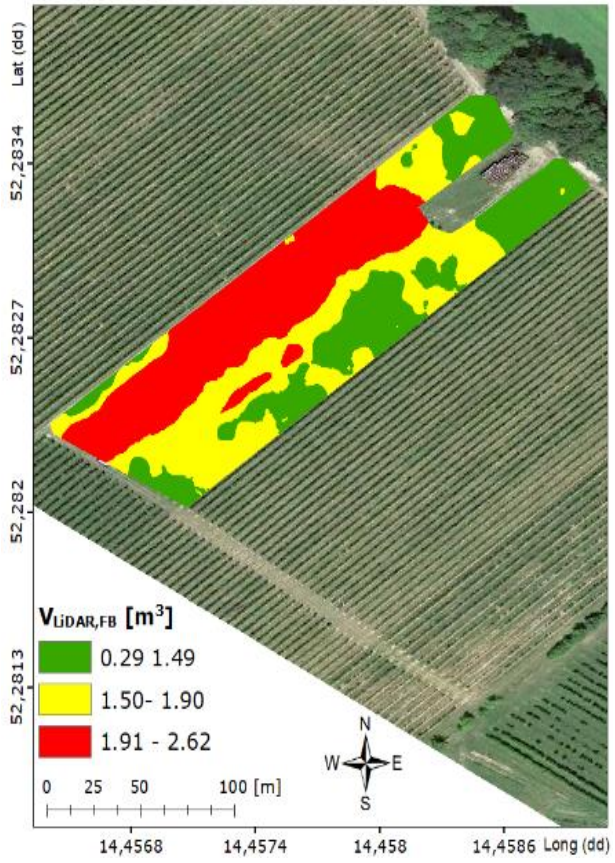


Tsoulias, N., Xanthopoulos G., Fountas S. and Zude-Sasse, M., 2021. Effects of soil ECa and LiDAR-derived leaf area on fruit quality in the apple production. Biosystems Engineering, (In review).

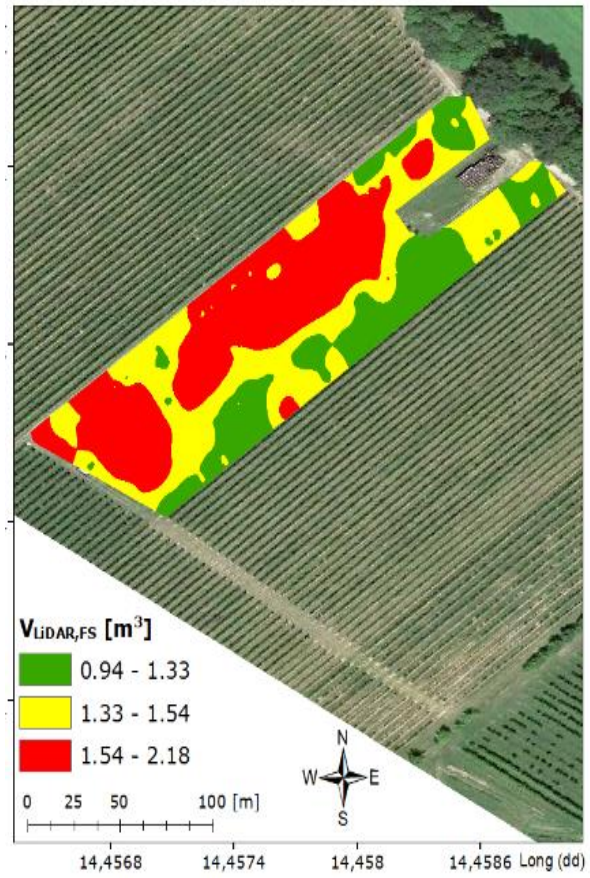


Tsoulias, N., Xanthopoulos G., Fountas S. and Zude-Sasse, M., 2021. Effects of soil ECa and LiDAR-derived leaf area on fruit quality in the apple production. Biosystems Engineering, (In review).

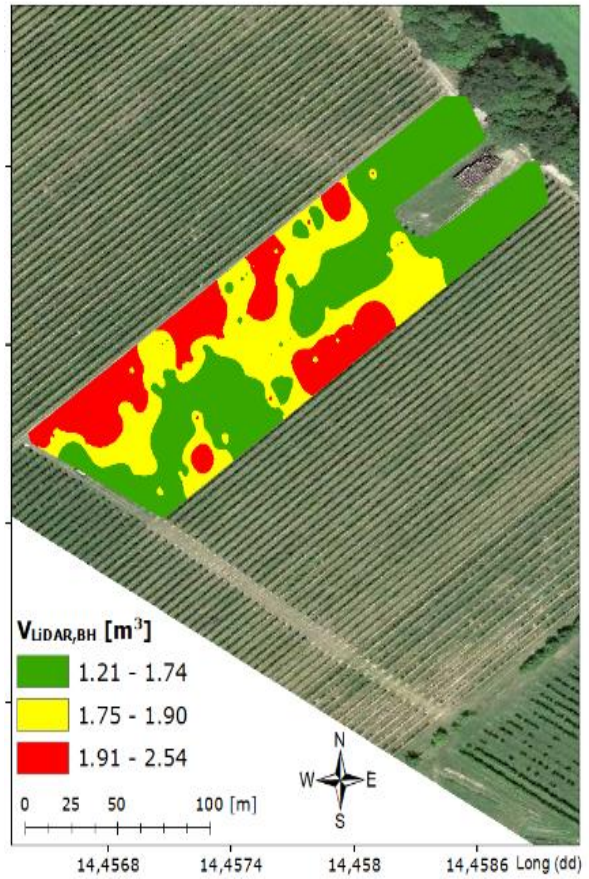
Full bloom
($DAFB_{10}$)



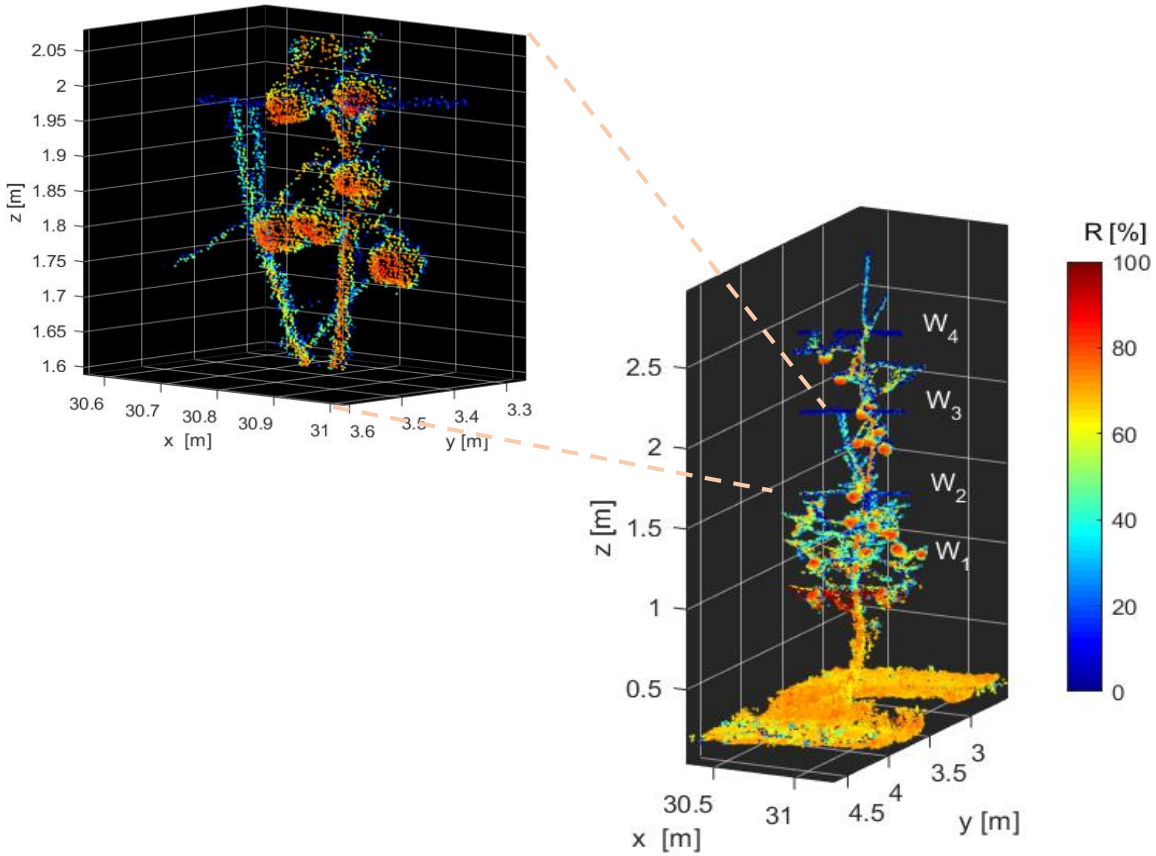
Fruit Set
($DAFB_{31}$)

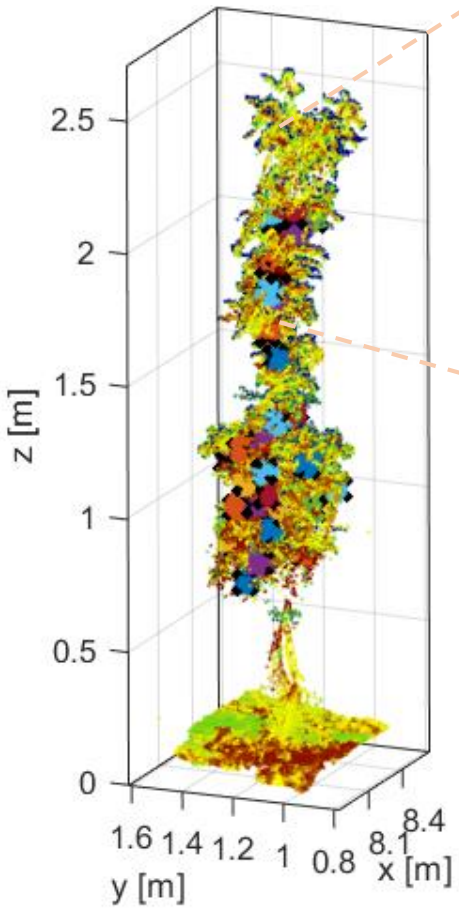


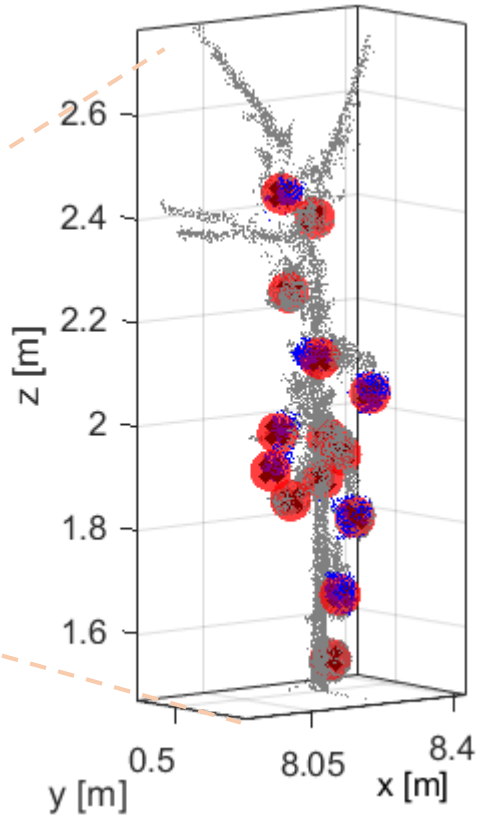
Harvest
($DAFB_{81}$)



Tsoulias, N., S. Fountas & Zude-Sasse, M. (2021). Estimating the canopy volume using a 2D LiDAR in apple trees. virtual 4th International Symposium on Horticulture in Europe (SHE/Virtual), 8. -11.03, Stuttgart, Germany.



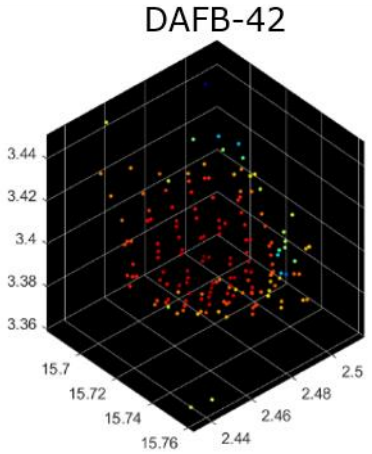


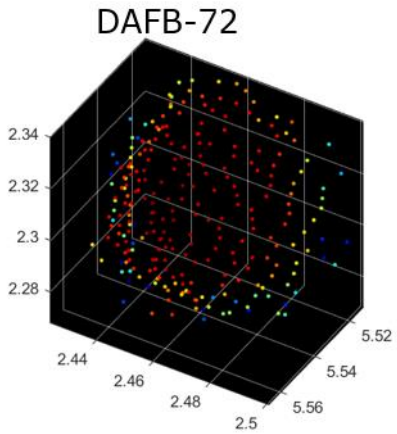


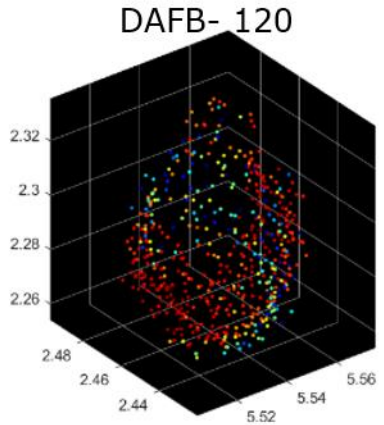
Fruit detection based on LiDAR point cloud:

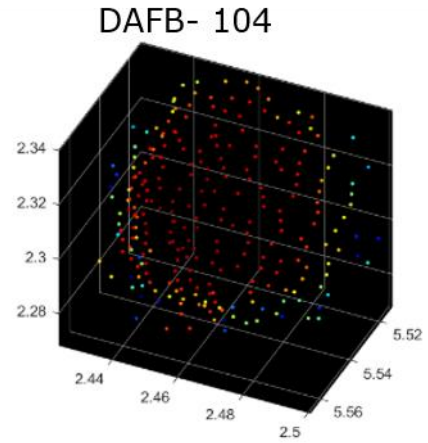
- Reflectance varies among tree elements
- Shape geometry
- Apple segmentation

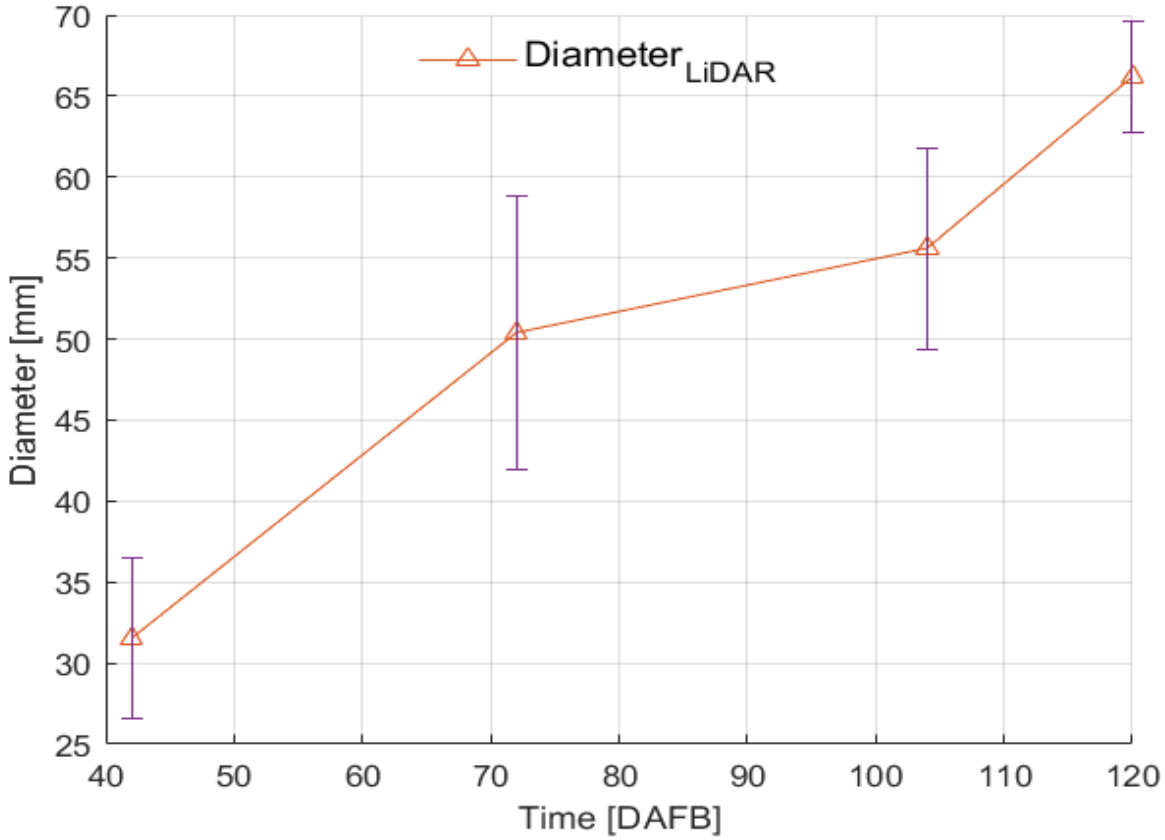
Tsoulias, Nikos, Dimitrios S. Paraforos, George Xanthopoulos, and Manuela Zude-Sasse. "Apple shape detection based on geometric and radiometric features using a LiDAR laser scanner." *Remote Sensing* 12, no. 15 (2020): 2481.







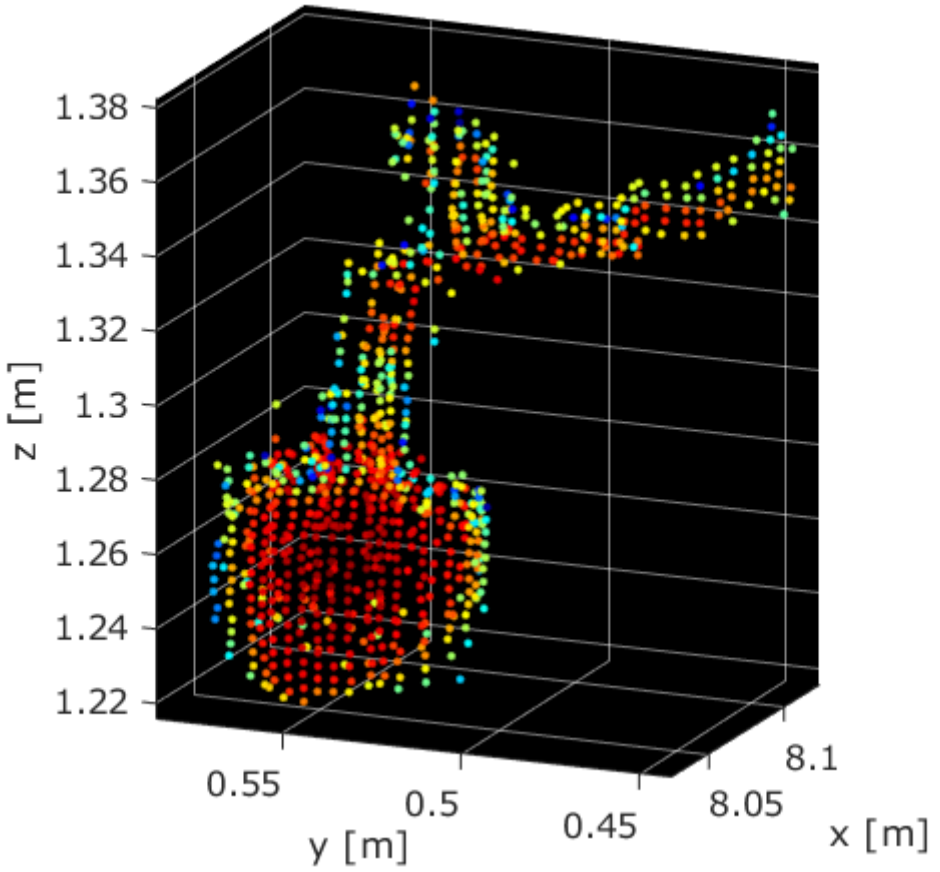




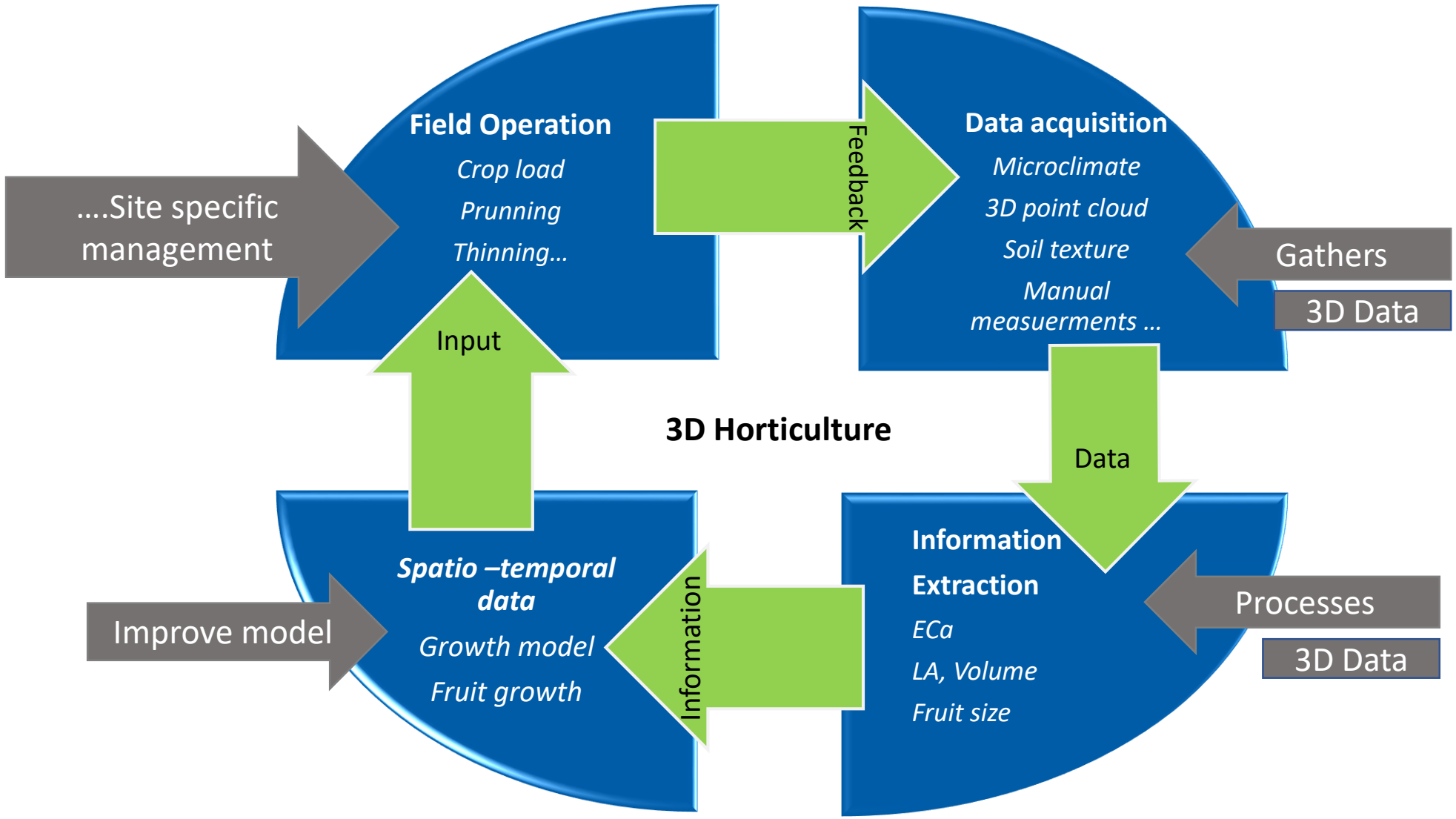
Tsoulias, Nikos, Dimitrios S. Paraforos, George Xanthopoulos, and Manuela Zude-Sasse. "Apple shape detection based on geometric and radiometric features using a LiDAR laser scanner." *Remote Sensing* 12, no. 15 (2020): 2481.

Overall:

- Acquire tree structural parameters in 3D.
- Repeated measurements allowed to observe spatio-temporal heterogeneity.
- Study and model the growth of e.g. LA, Volume
- Investigate the spatial relationship with field variables such as the ECa over the growth period.
- Create a fruit detection methodology which in not affected by light varying conditions.
- Fruit properties (Number, diameter, growth)
- Potential of management zone delineation and improving growth modeling.



Zude-Sasse M., Akbari E., Tsoulias N., Psiroukis V., Fountas S., Ehsan R. Sensing in horticulture. In : Sensing approaches for precision agriculture, Escolà A., Kerry R. Eds.;2021; Springer; US.


….Site specific management
Field Operation
Crop load
Prunning
Thinning…
Feedback
Data acquisition
Microclimate
3D point cloud
Soil texture
Manual measuerments …
Gathers
3D Data
Input
3D Horticulture
Data
Improve model
Spatio –temporal data
Growth model
Fruit growth
Information
Information Extraction
ECa
LA, Volume
Fruit size
Processes
3D Data

Thank you for your attention any questions?

ntsoulias@atb-potsdam.de

@TsouliasNikos

www.linkedin.com/in/nikos-tsoulias