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Understanding Forest Growth for Carbon Segregation, Biodiversity & Climate Adaptation

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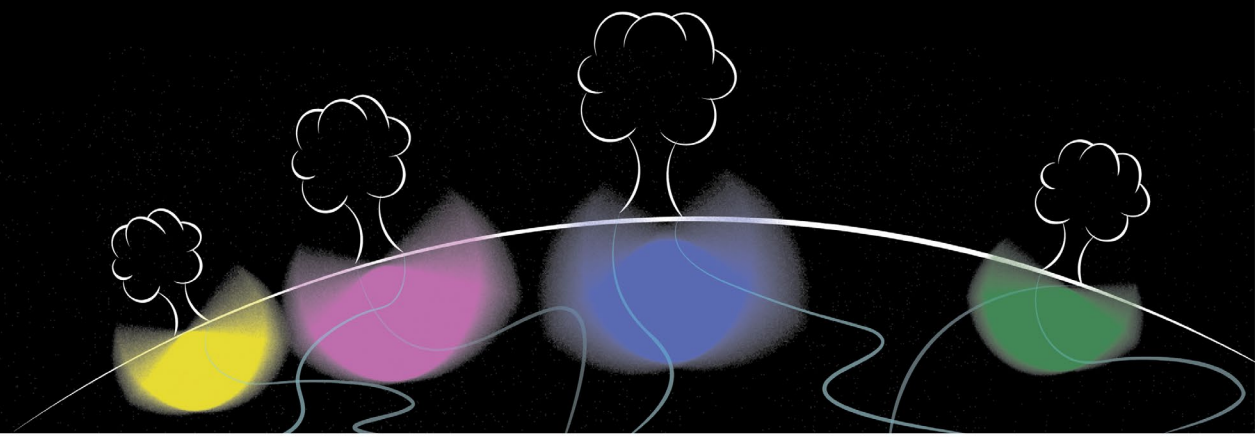
AI4TREES

ARTIFICIAL INTELLIGENCE FOR CLIMATE SENSITIVE TREE GROWTH MODELLING & MAXIMUM CARBON SEGREGATION



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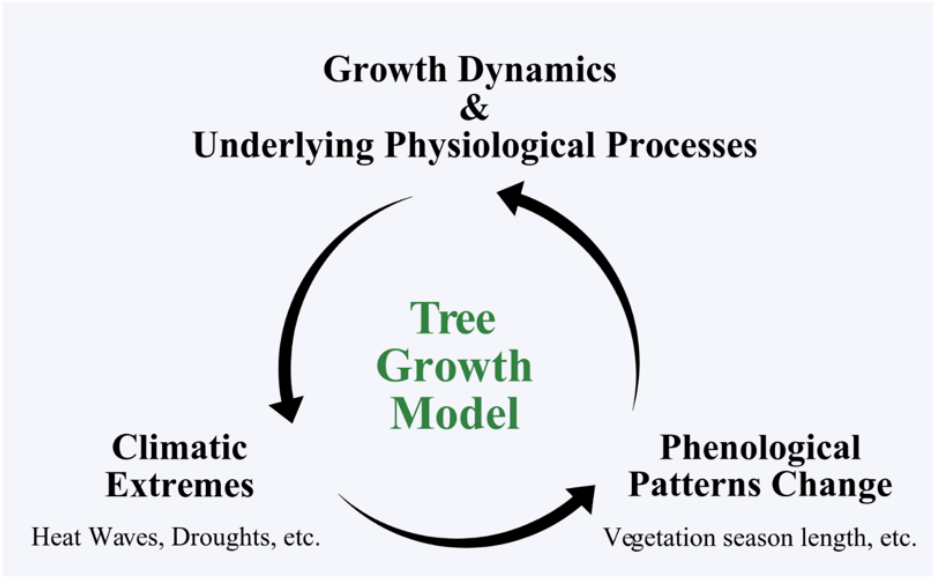
GOAL

Derivation of single tree growth models

that are sensitive to Climate Change, hazardous disturbance, and human intervention in forest ecosystems.

European Forests

Significant Carbon Sink **Mitigation of Climate Change & its Consequences**



Tree Growth

Tree Health **Carbon Sequestration**

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DATA COLLECTION

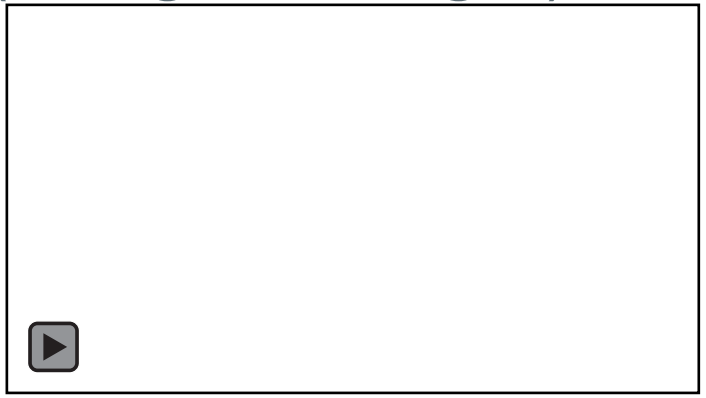
Collecting Data

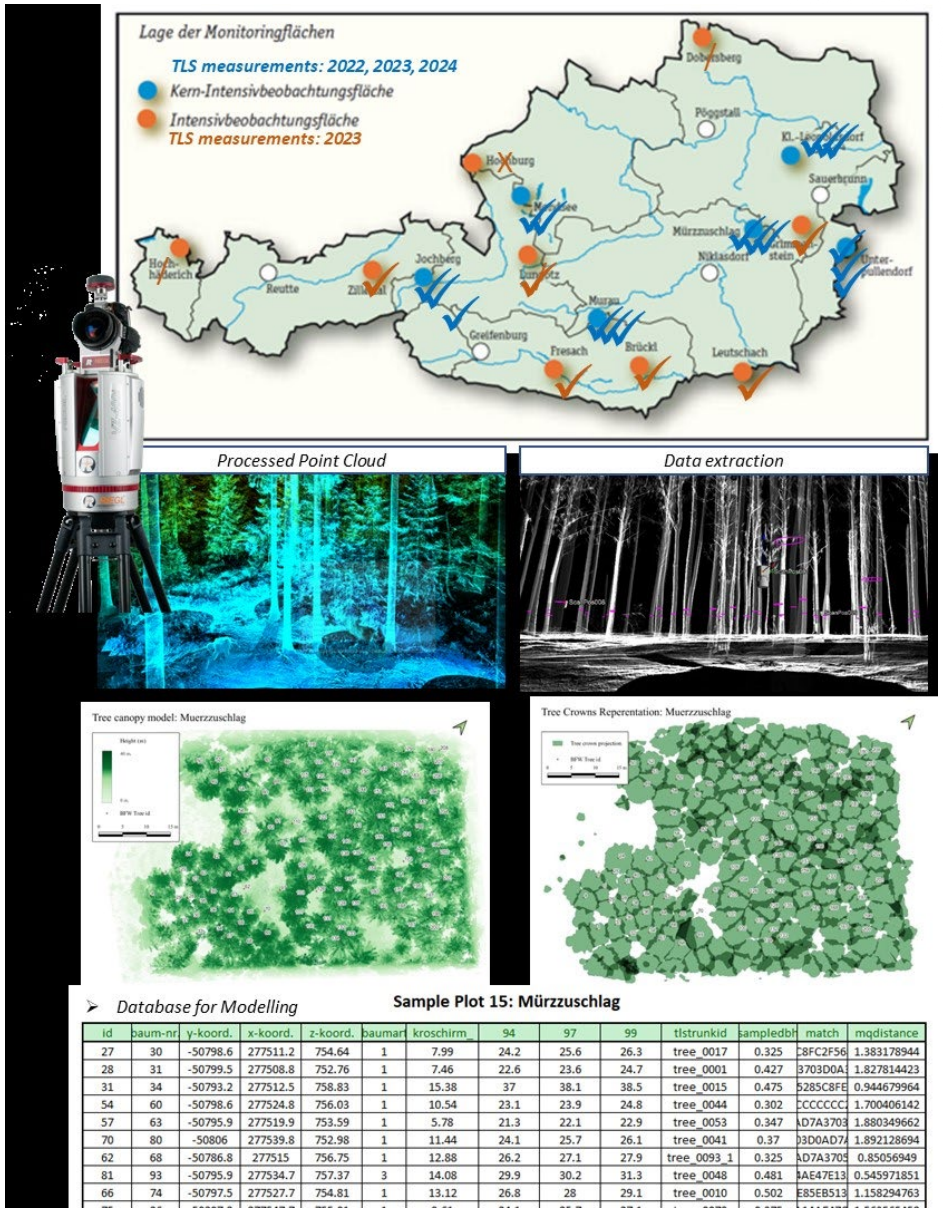
➢ Dendrometer data

- 15-minutes measurements
- Tree growth data (resolution: 1-5 µm)
- Electronic and manual

➢ Terrestrial Laser Scanning (TLS) data

- Point cloud
- Ultra high LIDAR sensor (0.7 angular mili-degree)





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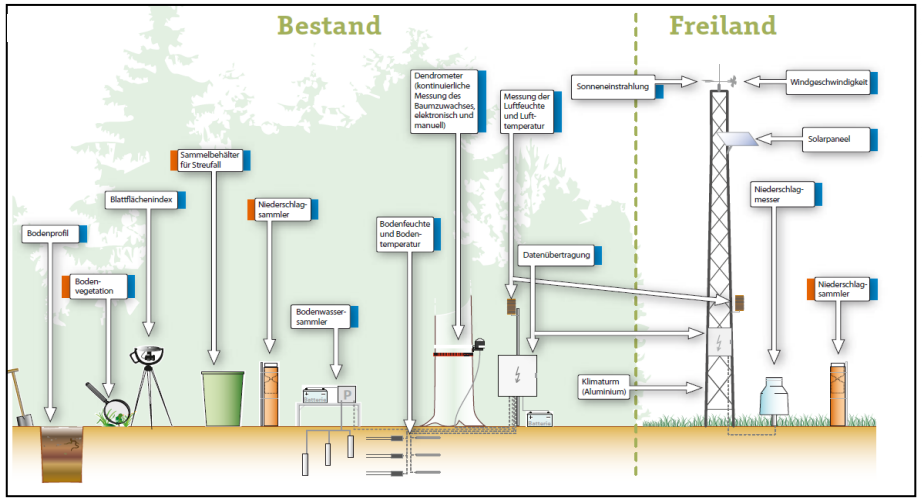
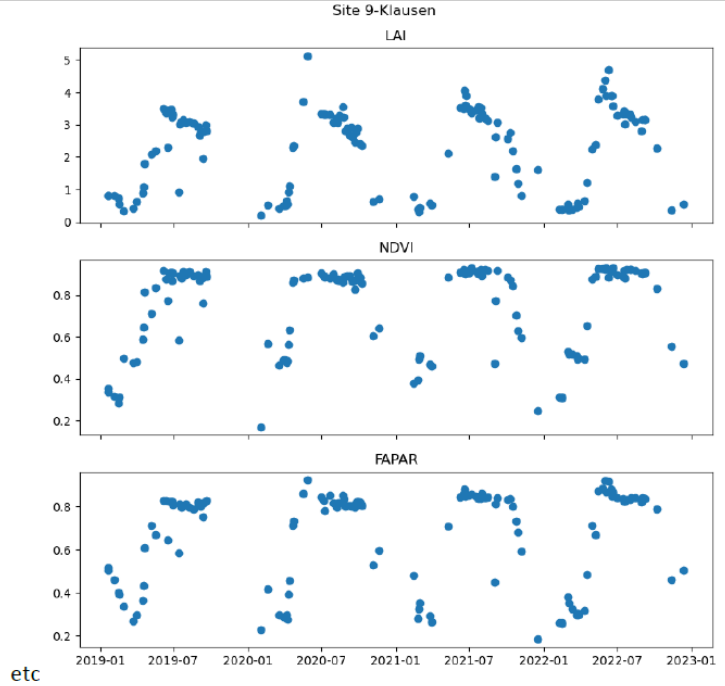
Collecting Data

- **Environmental data (air & soil)**
  - Temperature, humidity, wind, precipitation, etc.
- **Biodiversity data**
  - Manually derived stand and growth-related data: tree height, diameter, tree type, social status, etc.
- **Earth Observation:**
  - Data: Sentinel(s) & commercial sub-meter imagery
  - For:
    - Disturbances (due to logging, environment)
    - Single tree detection
    - Vegetation state



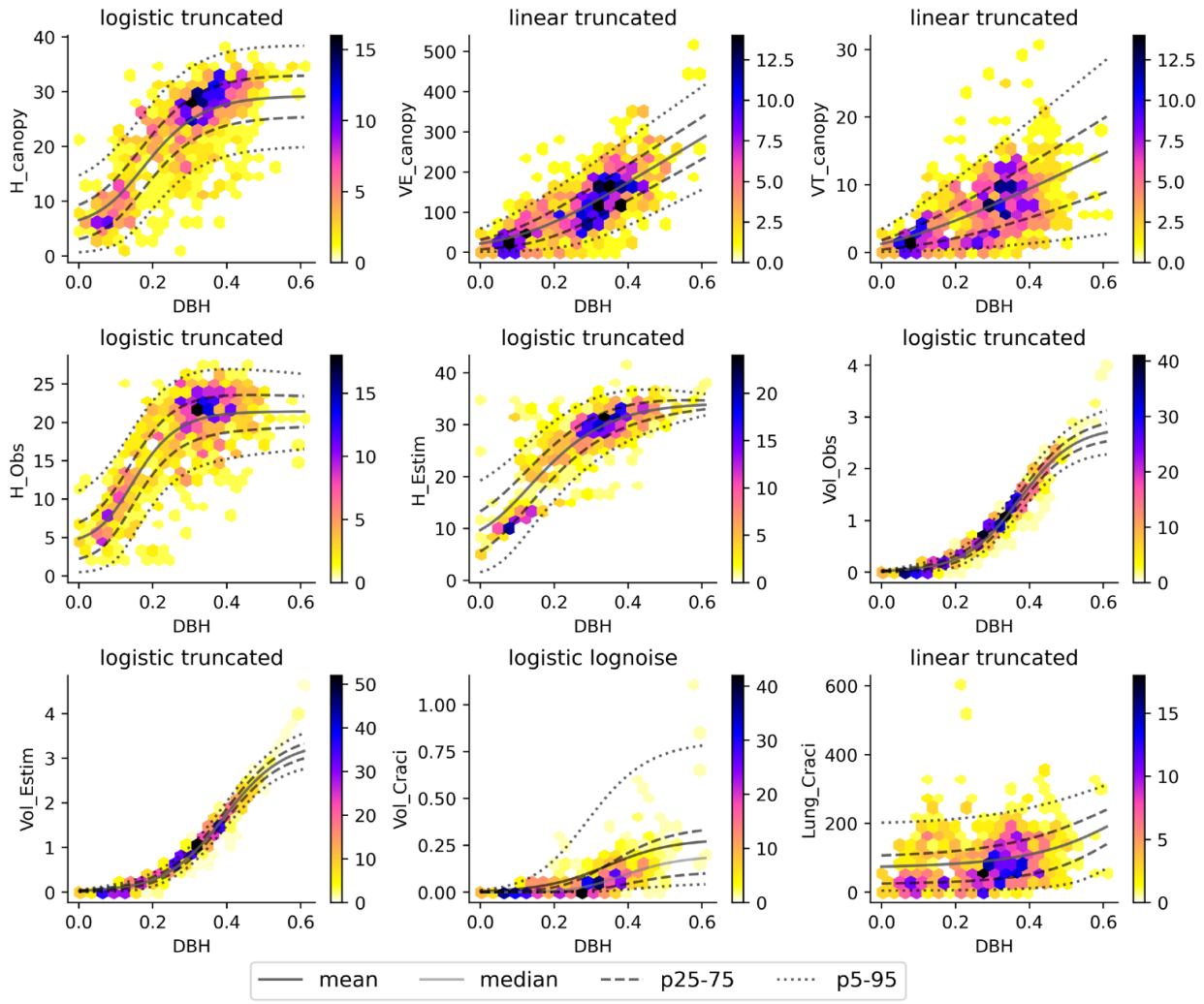


etc

Figure 3: Sentinel2 based LAI, NDVI and fAPAR time series plots of ICP Site Klausen

Modelling Tree Growth

- **Exploring data**:
  - TLS data to model parameters vs DBH (diameter at breast height)
  - Result: one can use a single TLS snapshot to learn something about the relationship between different tree variables not only across different trees, but also for single trees across different stages of their lifecycle.

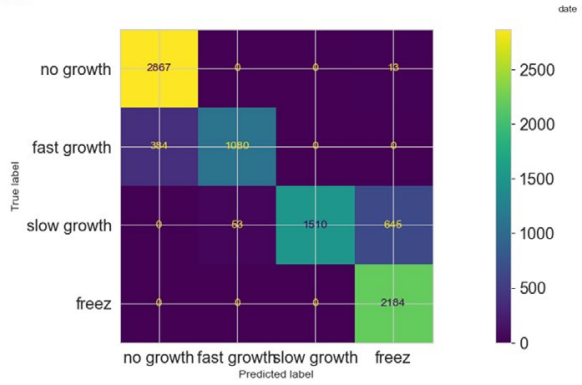


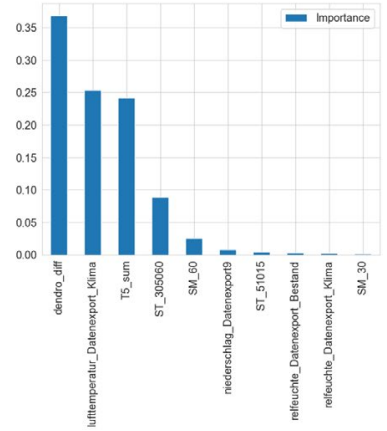
Modelling Tree Growth

➢ Data-centric AI approach

- Data: Dendromenter + Environmental
- Tree growth period classification
- Single-tree growth forecasting

Model	RMSE	R2
XGB Every 1 week	0.0726	0.8093
Prophet Every 1 week	0.1432	0.3867





What have we learned?

- **Challenging:**
  - To align data on single trees and/or stands
    - wrong geolocation/coordinates (manual vs automatic vs methodology)
    - thinning process and tree competitions not always sufficiently logged
  - Acquisition of EO data for training due to limited coverage and resolution
  - Dendrometer data acquisition need close supervision to avoid data loss
  - Forest management: lack of logs on soil management and treatments

- **Modelling:**
  - "Random" natural events – affecting the training data
  - Most of the jumps and gaps in data can be statistically addressed. Data can be properly cured in most of the cases
  - Variables measured with TLS can be statistically modelled
  - Using TLS snapshot data for long-term predictions

Forthcoming steps

- **Increasing the explainability of the model forecast**
  - by including expert feedbacks into explanations
  - by including already observed pattern (temporal changes observed in the past) and their frequency to justify model forecast

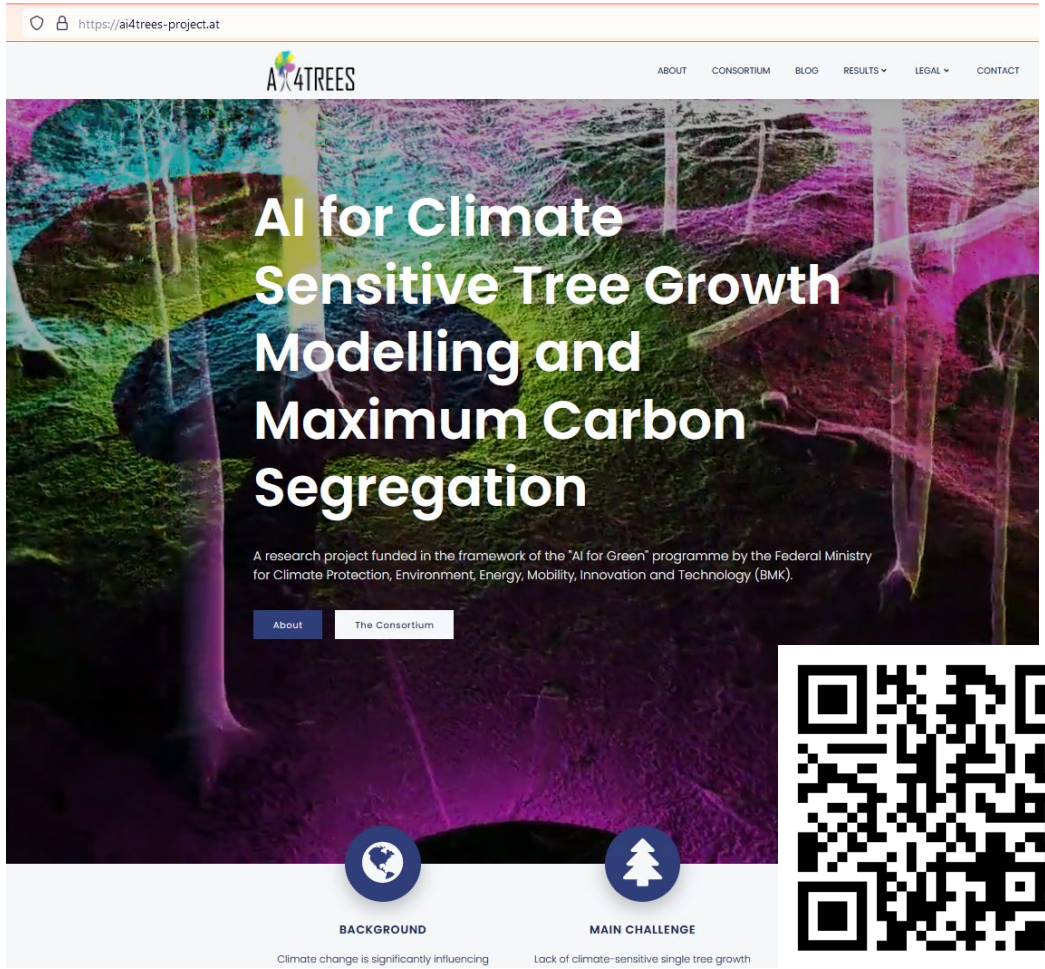
- **Explore in depth:**
  - TLS data collected at same spot over multiple years would likely be very valuable
  - Comparison of ANN and frequentist models performance, sensitivity and response to environmental variations
  - Categorization of model performance for specific applications for practitioners (which aproach is better for whom)
  - AI for tree growth – lack of data – estimate the longer term by adjusting the input values to the expected Climate models

Larger context?

- **What should be done in the larger context?**
  - Analyze the effect of tree competition and inter species as well as the role of forest structure development as response to climate change
  - Ensuring overlapping between temporal and geographical information of the collected data
  - Understanding other environmental players (other than temperature and moisture of air, soil, …) on the tree growth such as soil treatment and its effect on different species, etc.

Thank You!

Team



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