Estimating functional traits in Mediterranean ecosystems using spectroscopy from leaf to canopy scale

First results from the CHIME/SentHyMED campaign

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Outline of the presentation

- **Context & objectives of the SentHyMED project**
- **Ground data collection and laboratory measurements in 2021**
- **First results**
- **Perspectives**

Context & objectives of the SentHyMED project

- Mediterranean ecosystems will face important changes in biodiversity induced by climate change and direct human activities :
  - Drought and fires increase in frequency and intensity
  - Anthropic pressure for agriculture and urban areas
- Need to better understand phenology and water stress of Mediterranean forests

→ How to use remote sensing to monitor functional traits and water stress in Mediterranean forests ?

→ Synergies between Sentinel-2 time series and imaging spectroscopy ?

- Seven ground data collections from April to October 2021
- Specific ground data collection during CHIME campaign

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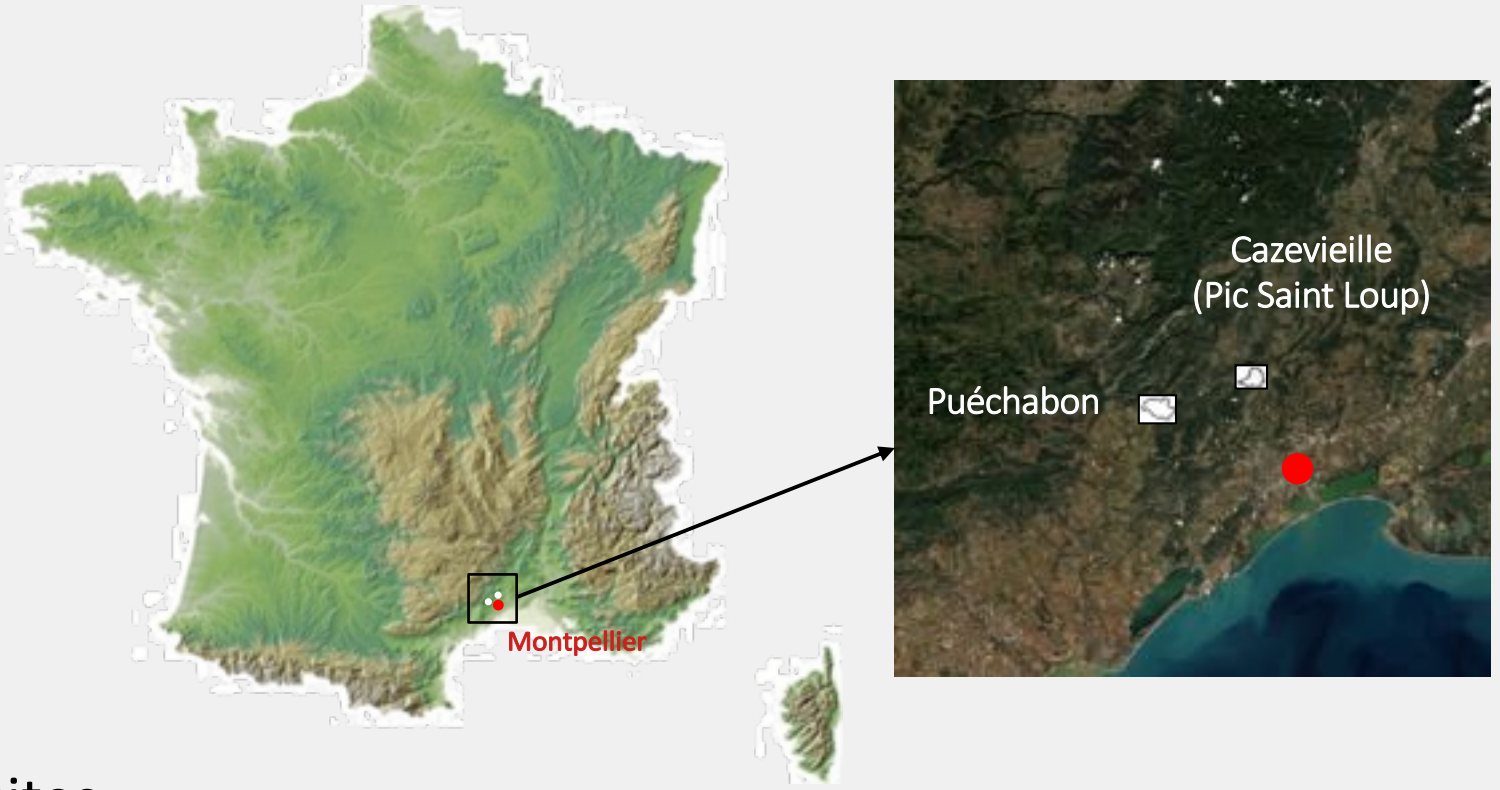
Study sites ~ 35 km North of Montpellier



- Two study sites :
  - Puéchabon (PUE): experimental site of managed forest dominated by *Quercus ilex*
    - Flux tower, temperature, weather station, phenocams
    - Regular measurement of LAI, LMA, water potential
  - Pic Saint Loup (PLS): *Quercus ilex* and *Quercus pubescens*

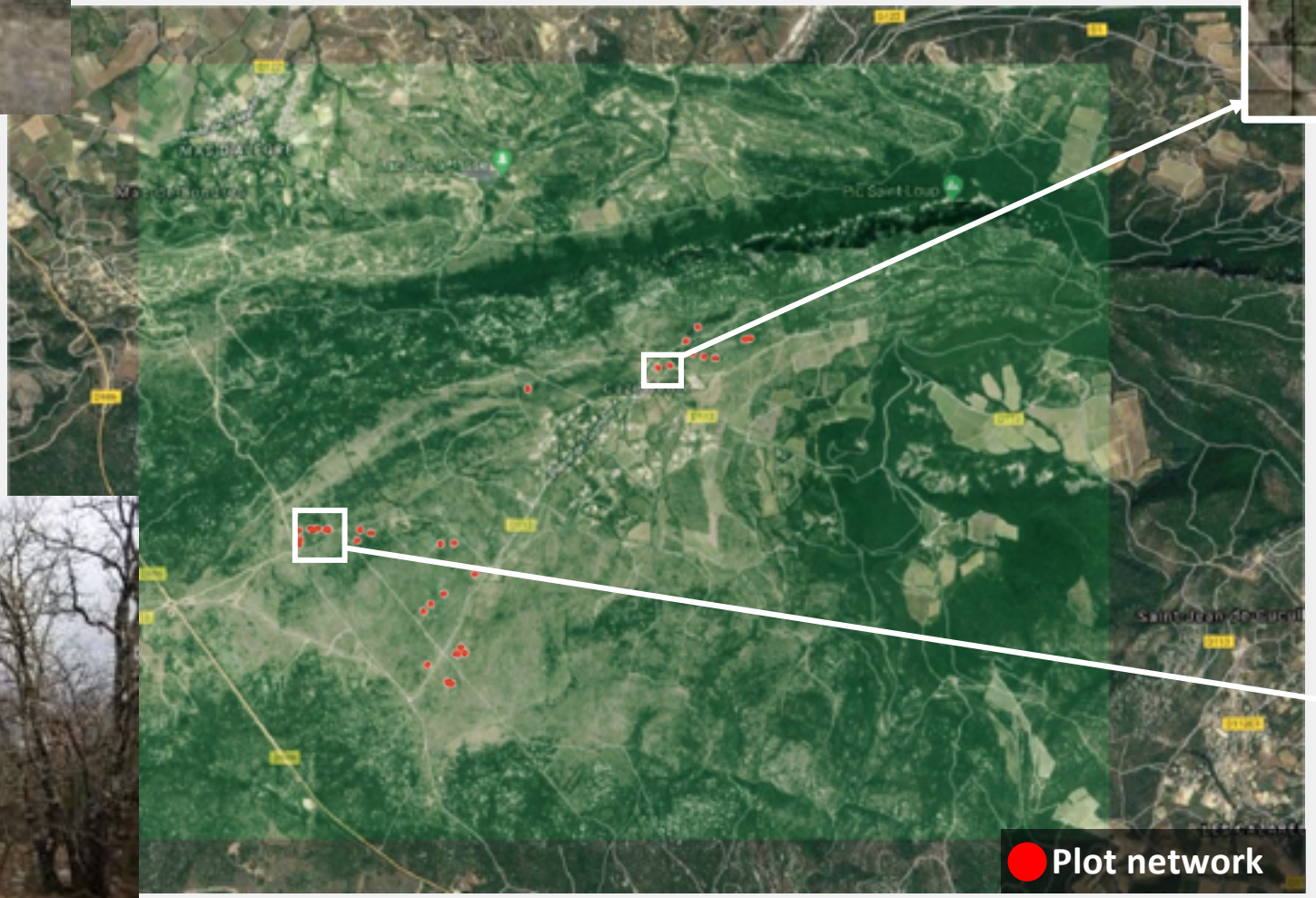
Study sites ~ 35 km North of Montpellier

Pic Saint Loup

→ Quercus ilex and Quercus pubescens

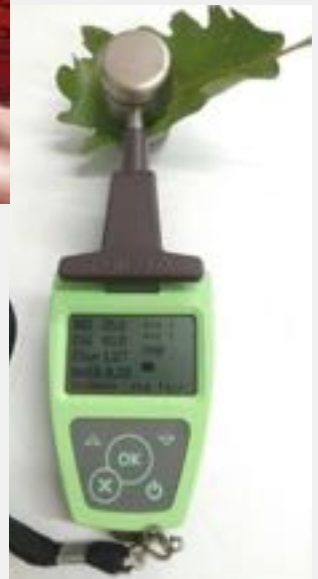
→ Moderate tree density

→ Tree crowns identified and delineated



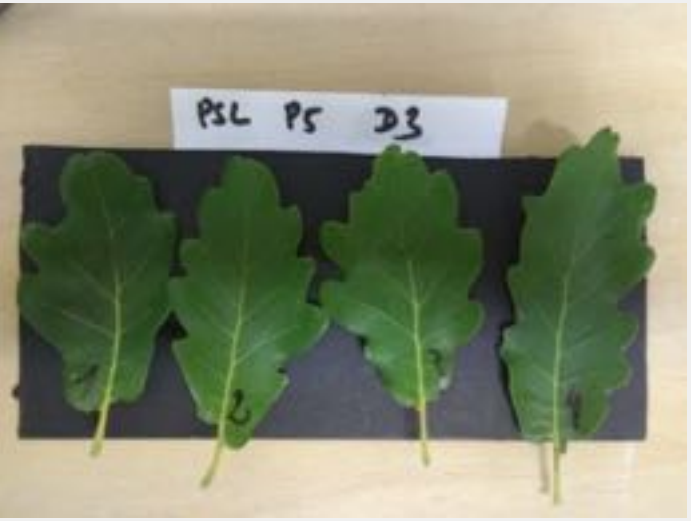
Ground data collection : leaf sampling & LAI

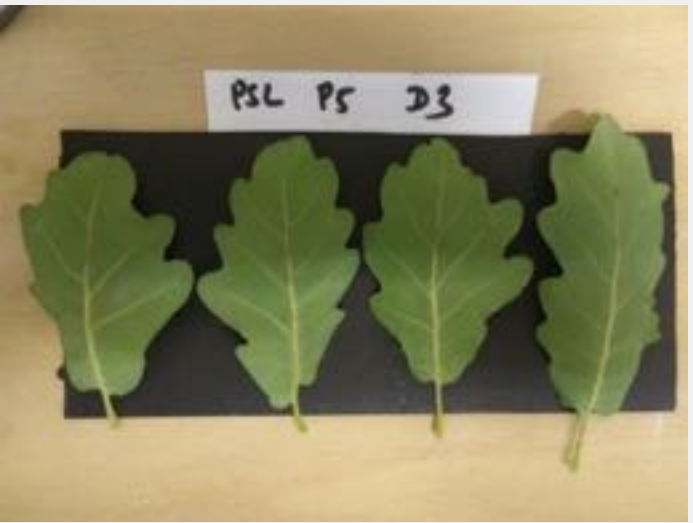
- Visit same individual trees during each campaign
- Measure LAI with LAI 2000
- Collect sunlit leaf samples
- Measure chlorophyll index with SPAD and DUALEX
- Store leaves in cooler for lab measurements (leaf optical properties, chemical measurements)



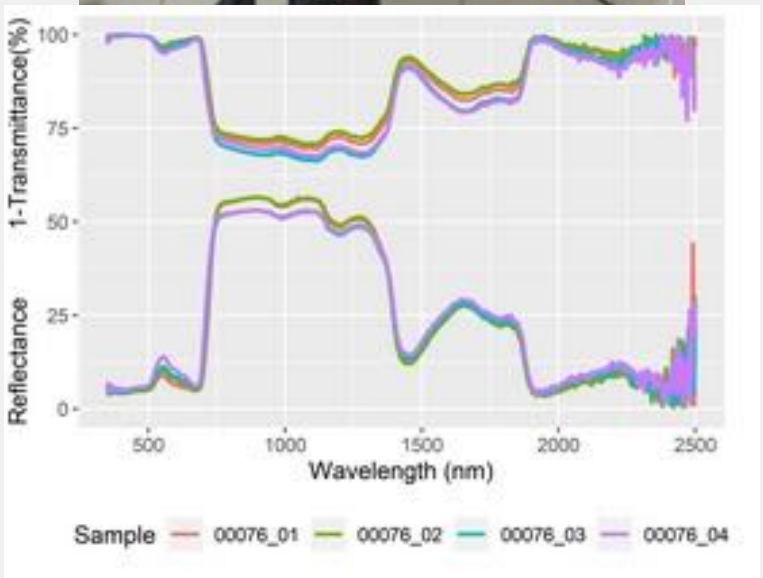
Laboratory analysis of leaf samples

- **Leaf optical properties (R & T) measured with ASD equipped with integrating sphere**
- **Leaf material sampling for destructive measurements (pigments, LMA, EWT)**





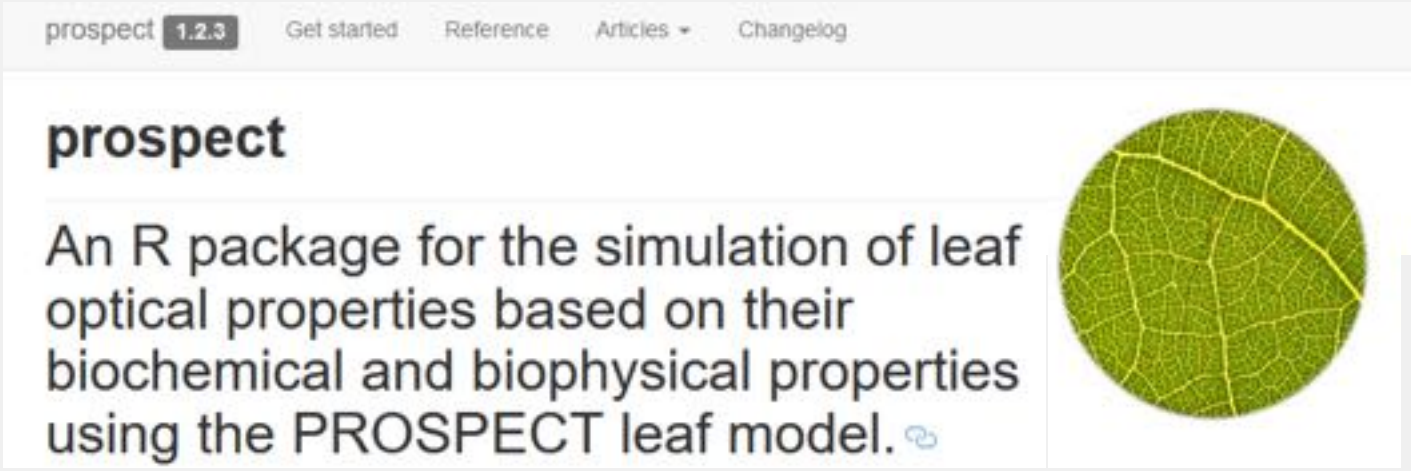
Leaf optical properties

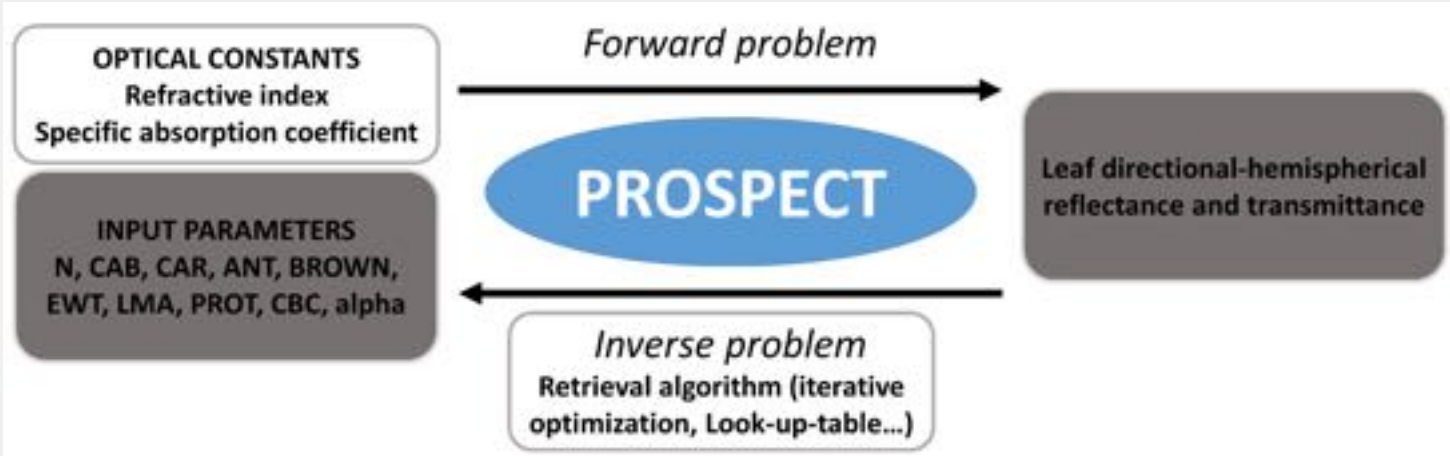


Fresh & dry mass
Pigment extraction

Estimating leaf chemistry from optical properties with PROSPECT inversion

- **Estimation of leaf chemical composition using iterative optimization**
- **Comparison with lab measurements**
- **All codes available here: https://jbferet.gitlab.io/prospect/**





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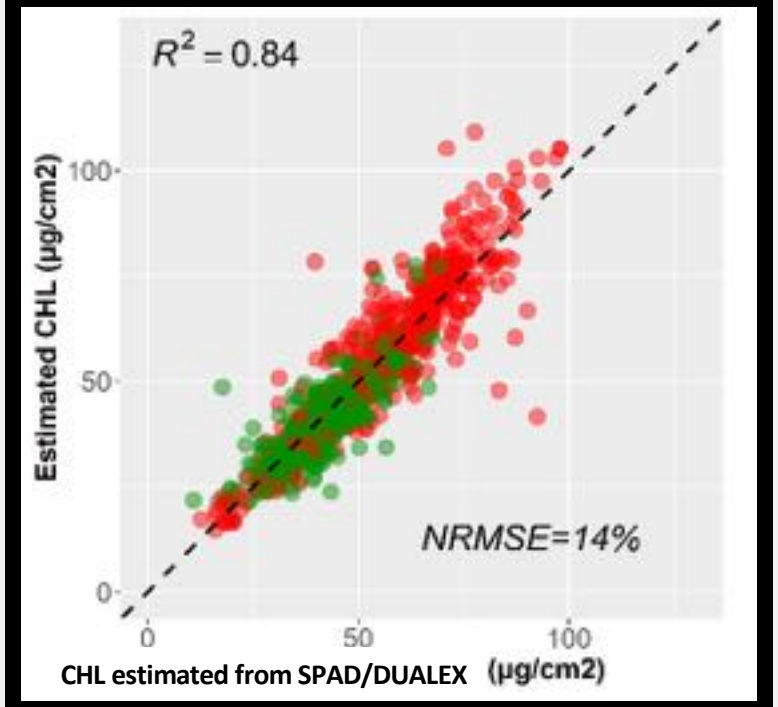
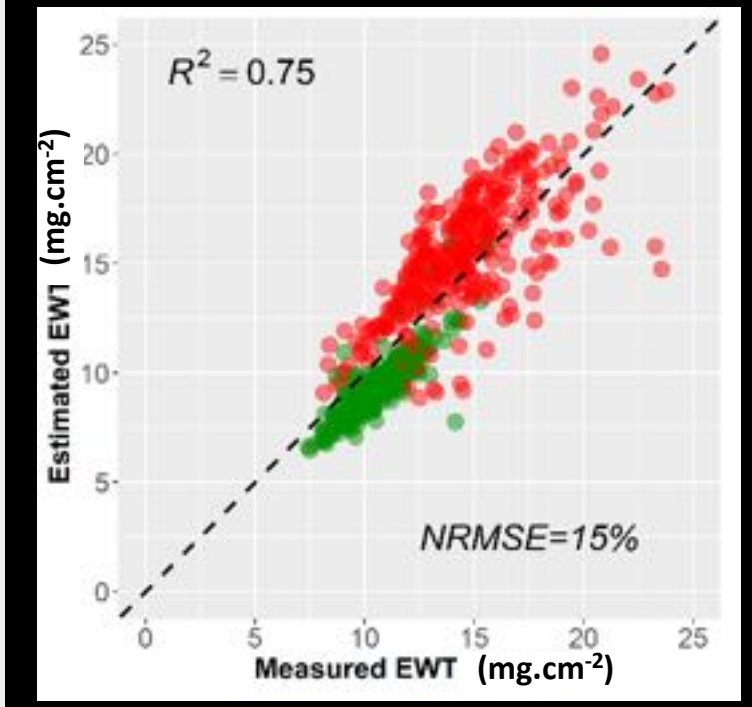
First results : estimation of leaf chemical constituents

- **PROSPECT inversion**
  - Estimated EWT and LMA compared with destructive measurements
  - Estimated chlorophyll compared with SPAD and Dualex measurements

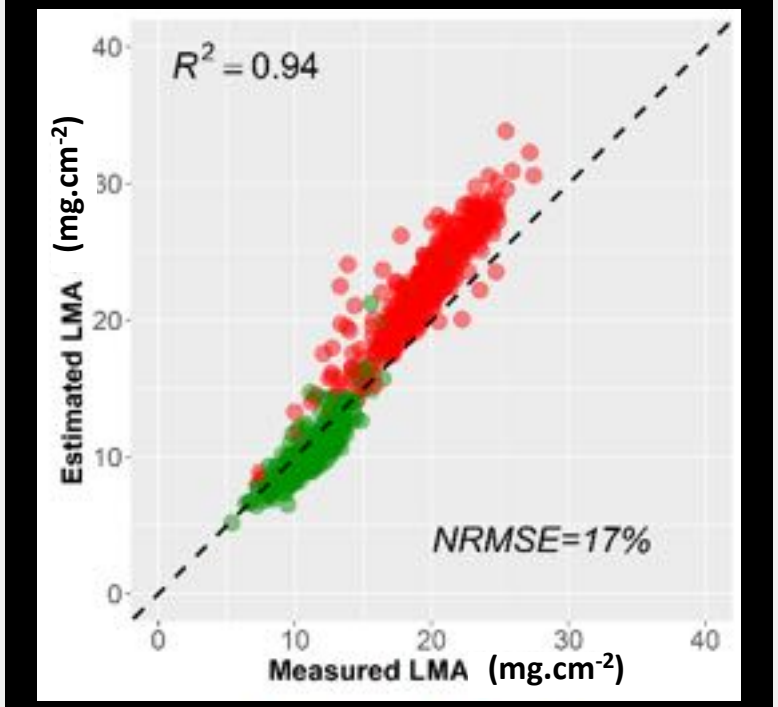
Leaf chlorophyll content



Equivalent Water Thickness



Leaf Mass per Area



● *Quercus ilex* ● *Quercus pubescens*

→ Performances in agreement with those obtained with independent datasets
→ Systematic bias needs further investigations

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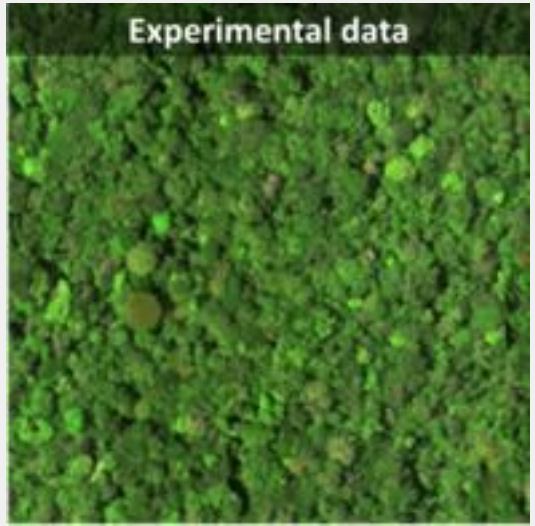
- **Estimate vegetation properties based on airborne and satellite images**
  - **Hybrid inversion based on simulations obtained from 1D (SAIL) and 3D (DART) physical models combined with machine learning**

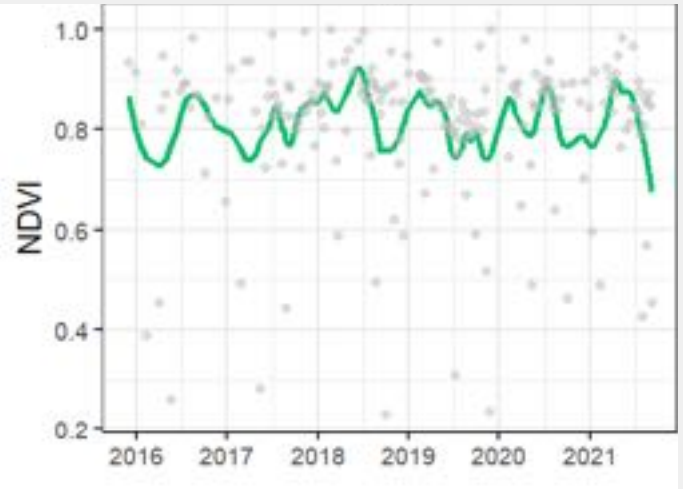


https://pytools4dart.gitlab.io/pytools4dart/

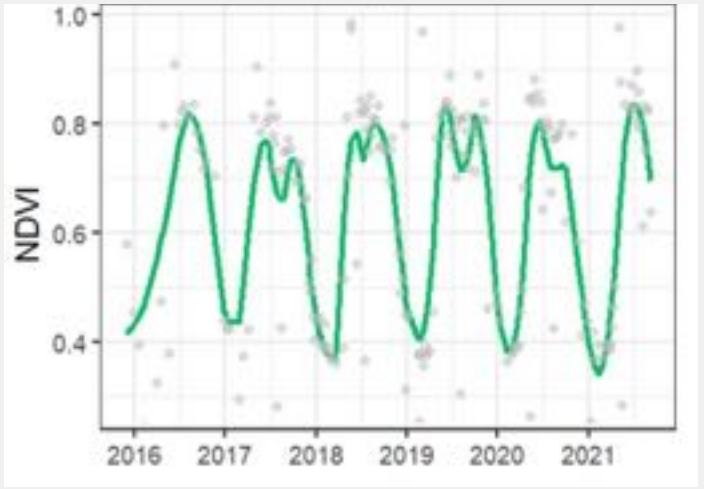
Perspectives

- **Estimate vegetation properties based on airborne and satellite images**
  - **Hybrid inversion based on simulations obtained from 1D (SAIL) and 3D (DART) physical models combined with machine learning**
- **Perform validation based on ground data acquisitions**
- **Explore seasonality of vegetation properties for full S2 time series**
- **Analyze and compare DESIS & PRISMA acquisitions**

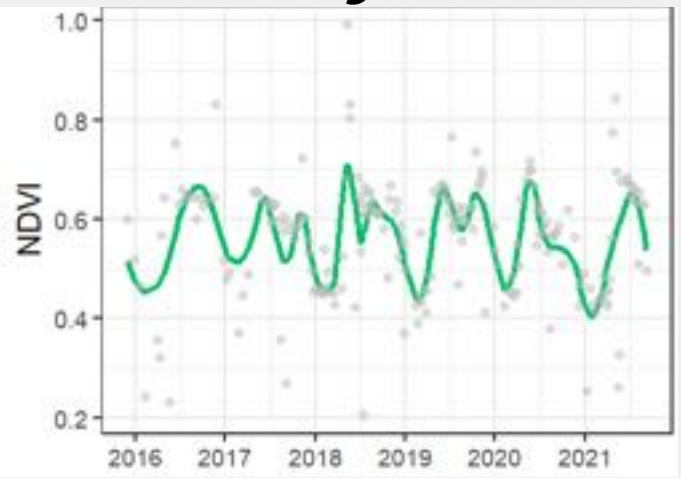
Puéchabon
100 % Quercus ilex



100 % Quercus



Pic Saint Loup
Mixed vegetation



NDVI time series obtained from Sentinel-2 data over plots located in Puéchabon and Pic Saint Loup


Thank you !
Questions?