BIOPHYSICAL AND CONTEXTUAL MODELLING FOR FOREST PLANTATIONS DISTURBANCES

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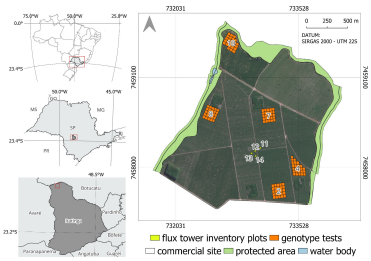
Introduction

Forest ecosystems are increasingly vulnerable to climate-related disturbances. Optical remote sensing has long been used to detect anomalies like fire and pest outbreaks, often relying on spectral vegetation indices (SVI) (Gao et al., 2020). While these studies successfully identify anomalies through SVI thresholds, they often lack insight into changes in vegetation structure and biochemical components. Monitoring biophysical properties such as leaf area index (LAI), chlorophyll content (Cab), leaf mass per area (LMA) and leaf water content (EWT) is crucial for understanding plant-environment interactions. **This study aims to detect forest plantation disturbances by monitoring biophysical properties in Eucalyptus plantations using Sentinel-2 images.** The focus is on radiative transfer models (RTM) and inversion strategies to estimate biophysical properties (LAI, Cab, LMA and EWT) to assess anomalies such as fire risk. **This poster highlights the data processing and testing efforts related to using the PROSAIL model as a radiative transfer model (RTM).**

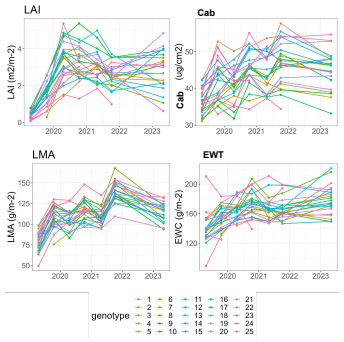
Keywords: Radiative transfer models, PROSAIL, Biophysical Variables retrieval, Forestry

Materials and Methods

Study area

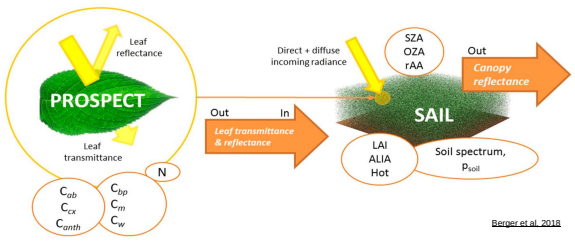


In-situ data



Model

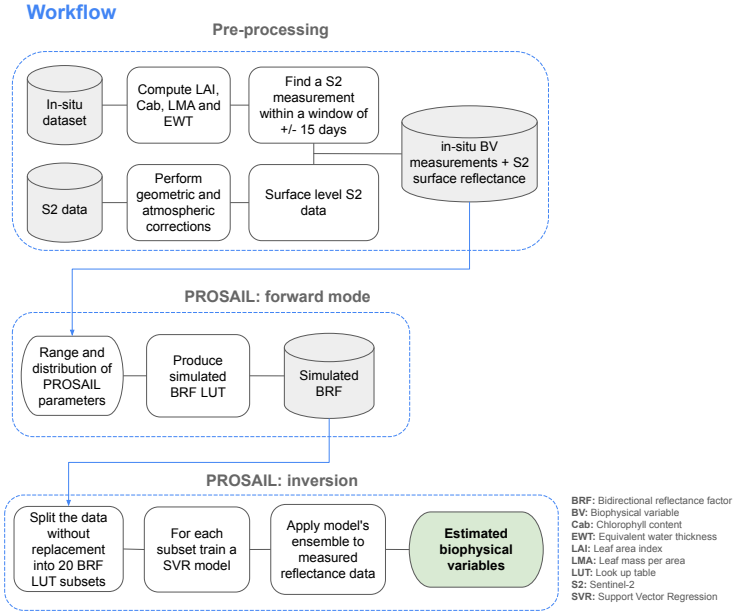
PROSAIL



Berger et al. 2018

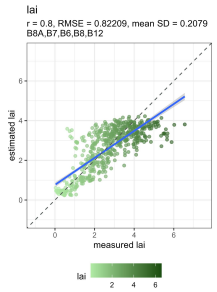
Cab : chlorophyll a + b
Ccx: Total carotenoid content
Canth: Total anthocyanin content
Cbp: Brown pigments
Cm: Dry matter content
Cw: Equivalent water thickness
N: Leaf structural parameter
LAI: Leaf area Index
ALIA: Average leaf inclination angle
Hot: Hot spot parameter
psoil: Soil spectrum
SZA: Sun zenith Angle
OZA: Viewing (observer) zenith angle
rAA: Relative zenith angle

Workflow

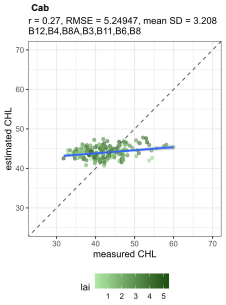


BRF: Bidirectional reflectance factor
BV: Biophysical variable
Cab: Chlorophyll content
EWT: Equivalent water thickness
LAI: Leaf area index
LMA: Leaf mass per area
LUT: Look up table
S2: Sentinel-2
SVR: Support Vector Regression

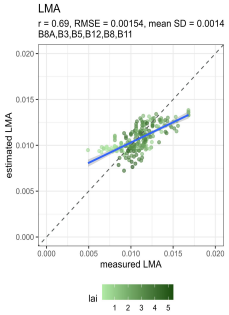
Results



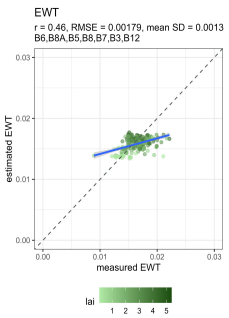
- LAI is the ratio between the total leaf area and the ground area.
- This variable is involved in various functions, such as canopy radiation balances (e.g. photosynthesis net primary production, etc.)
- **It is very well estimated by inverting PROSAIL with a RMSE of 0.82 m²/m²**



- Cab is the main leaf pigment responsible for light absorption in plants and is an indicator of plant photosynthetic capability.
- **It is very poorly estimated by inverting PROSAIL**
- The unsatisfactory results may be due to several reasons, such as model parametrization, correlation with other variables, high Cab variability within the canopy, among others.



- LMA corresponds to the leaf dry mass per unit area. The LMA is key in many plant adaptation strategies.
- For instance, low LMA species typically have rapid metabolisms (high rates of photosynthesis and respiration per unit leaf dry mass)
- **It is well estimated by inverting PROSAIL with a RMSE of 0.0154 g/m²**



- EWT refers to a hypothetical water layer thickness spread across the leaf surface
- It is yet another crucial attribute for assessing plant physiology, ecosystem processes, hydraulic status, and leaf-level tolerance to dehydration.
- **It is modestly well estimated by inverting PROSAIL with a RMSE of 0.00179 g/m²**

Take home messages

This study focused on estimating biophysical variables (BVs) such as LAI, chlorophyll content (Cab), LMA, and EWT by simulating spectral measurements using PROSAIL in forward mode. A machine learning algorithm was then applied to estimate these BVs from the simulated data. **Key findings highlight the critical importance of model parameterization, noise levels, background spectra selection, and spectral subdomain choice when using radiative transfer models (RTMs). Accurately estimating Cab, however, remains a challenging task that continues to be a subject of investigation.**

Acknowledgements

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References

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