PROSPECT-PRO: a leaf radiative transfer model for estimation of leaf protein content and carbon-based constituents

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INTRODUCTION

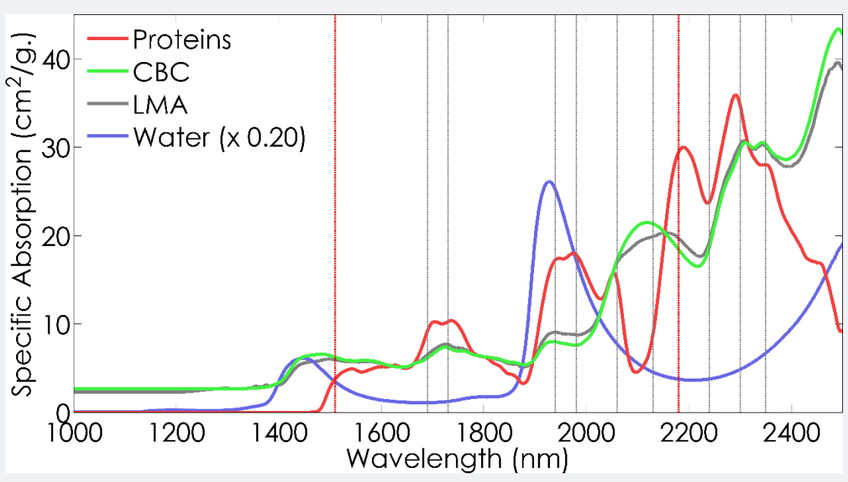
- Monitoring **leaf nitrogen content** (N) is key for applications in agriculture and ecology
- *Leaf chlorophyll content is used as proxy for N when using remote sensing, while **leaf protein content** appears as more relevant for N monitoring*
- *Increasing availability of imaging spectroscopy from proximal sensors to satellites : access to leaf constituents otherwise unreachable*

→ ***We developed a new version of the leaf model PROSPECT splitting leaf dry matter (LMA) into*** **proteins and carbon-based constituents (CBC)**

CALIBRATION

- Calibration & validation samples selected from fresh & dry samples of the LOPEX dataset (50/50)
- Calibration designed to distribute the absorption from leaf dry matter between proteins and CBC

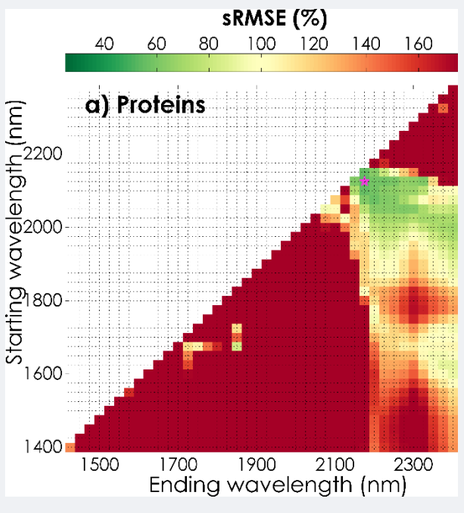
→ **Specific absorption coefficients show expected absorption features**



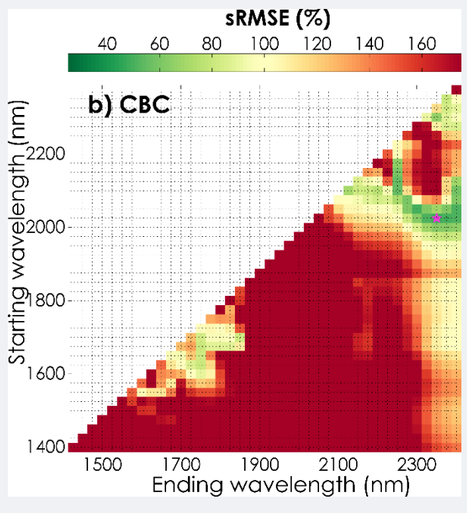
IDENTIFYING OPTIMAL SPECTRAL DOMAIN

- Estimation of LMA improved when using spectral subdomains [1]
- We identified which spectral subdomains result in optimal estimation of leaf proteins and CBC

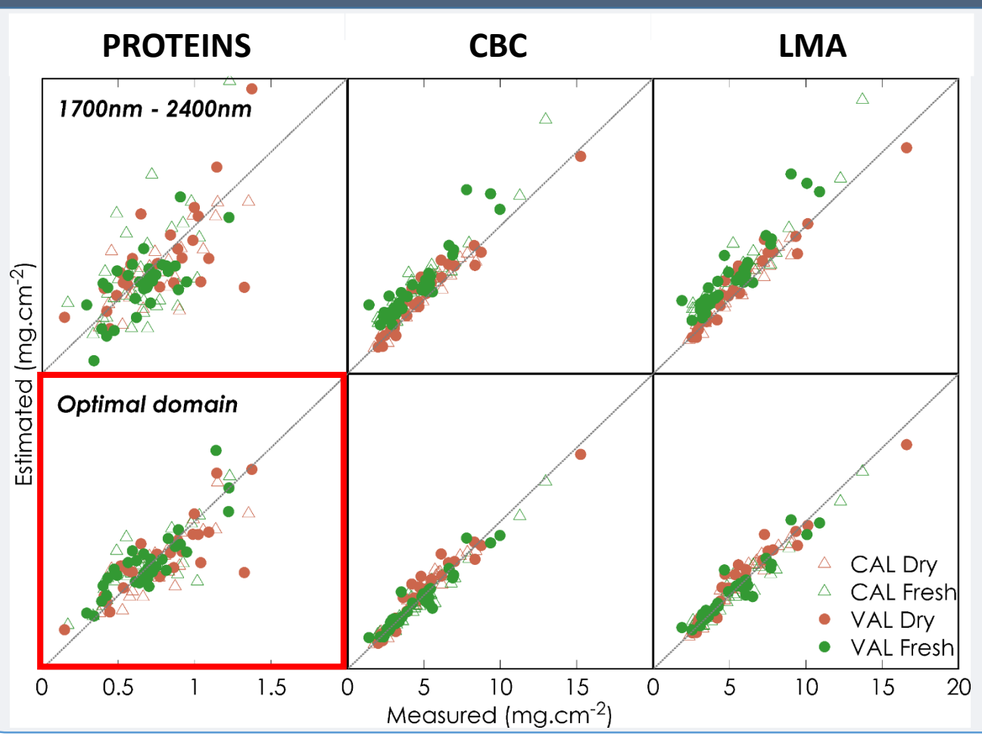
Proteins: from 2125 to 2175 nm



CBC: from 2025 to 2350 nm



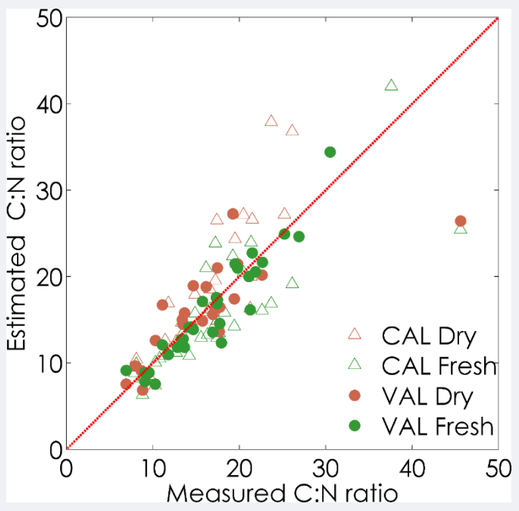
VALIDATION: estimation of leaf protein content, C/N ratio & compatibility with PROSPECT-D

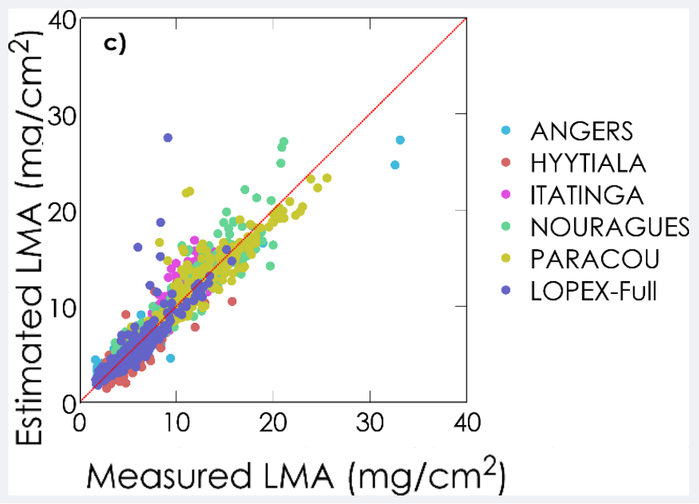


→ **Accurate estimation of leaf proteins and CBC for both fresh and dry samples**

→ **Accurate estimation of Carbon / Nitrogen ratio from fresh & dry leaves**

→ **Improved estimation of LMA computed from PROSPECT-PRO inversion**





CONCLUSIONS

- PROSPECT-PRO is able to **accurately estimate leaf protein content** and CBC from leaf optics in the SWIR domain, for both **fresh and dry leaves**
- PROSPECT-PRO is **fully compatible** with PROSPECT-D: no decrease in performances when computing **LMA = Proteins + CBC**
- PROSPECT-PRO is able to **accurately estimate C:N ratio** of vegetation based on the CBC : Proteins ratio
- A manuscript has been submitted to RSE [2] and the new version of the model is available here:
  https://gitlab.com/jbferet/prospect_pro_matlab
- A new **R package prospect** to be released soon, including latest versions, inversions procedures and more:
  https://jbferet.gitlab.io/prospect/

REFERENCES

[1] Féret, J.-B et al. (2019). Estimating leaf mass per area and equivalent water thickness based on leaf optical properties: Potential and limitations of physical modeling and machine learning. *Remote Sens. Environ*. 231, 110959. https://doi.org/10.1016/j.rse.2018.11.002

[2] Féret, J.-B et al. (submitted). PROSPECT-PRO: a leaf radiative transfer model for estimation of leaf protein content and carbon-based constituents. https://arxiv.org/abs/2003.11961

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