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An advanced leaf optical properties model including photosynthetic pigments

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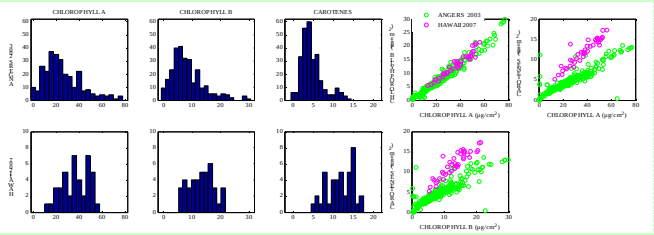
1. Introduction

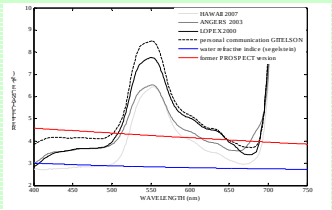
- The current spectral resolution (5 nm) of *PROSPECT* is not sufficiently accurate to benefit from hyperspectral remote sensing data and applications such as fluorescence which need very high spectral resolution. Databases at 1 nm resolution are now available that provide an opportunity to upgrade the model.
- *PROSPECT*'s ability to discriminate leaf pigments is still unknown, as the current parameterization assumes chlorophyll is the only absorbent pigment in the visible domain.
- Some intrinsic parameters of the model have never been updated since it was first set up.

2. Available datasets



Pigment distribution in the ANGERS 2003 & HAWAII 2007 databases

	Nb. of leaves	Nb. of species	*mean(Chl A)*	*mean(Chl B)*	*mean(Carot)*
ANGERS 2003	276	49	25 µg/cm²	9 µg/cm²	5 µg/cm²
HAWAII 2007	41	41	37 µg/cm²	13 µg/cm²	12 µg/cm²



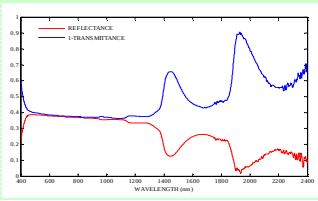
Experimental minimum reflectance and PROSPECT theoretical minimum reflectance

The leaf hemispherical reflectance and transmittance have been measured from 400 nm to 2400 nm using ASD FieldSpec instruments equipped with integrating spheres. The experimental data point out:

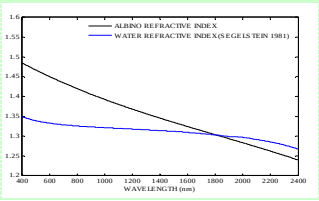
- *PROSPECT*'s limit in assessing high absorption values (chlorophyll in the VIS & water in the SWIR).
- the primary importance of the calibration of the spectroradiometers and integrating spheres.

3. A new method for calibration

- A comprehensive knowledge of the leaf pigments needs to consider scattering, accounted for by the refractive index. A new leaf refractive index spectrum has been assessed using albino maize leaves, the thinnest and simplest leaf sample, seen as a single layer with minimum absorption.

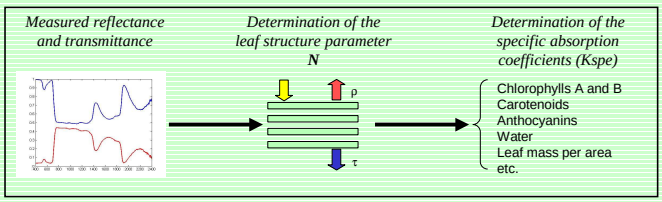


Optical properties of an albino maize leaf



Refractive index computed from the albino leaf. In blue: water refractive index (Segelstein, 1981)

- Diagram of the calibration:

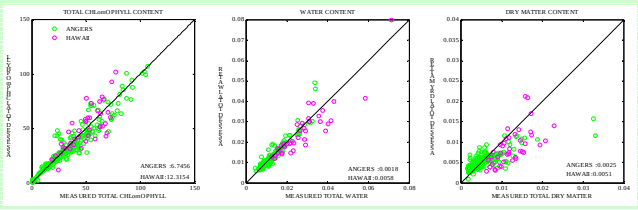


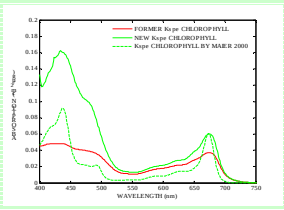
- Kspe of the dry matter was not retrieved in this study because only fresh leaves were available.

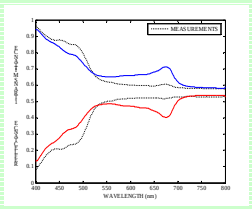
4. Results

The model was calibrated on the ANGERS 2003 database. Inversions were performed on reflectance and transmittance spectra using an iterative method (Powell).
Measured and estimated values of the leaf constituents are compared on both the ANGERS 2003 and HAWAII 2007 databases.

- Discrimination of total chlorophyll, water, and dry matter

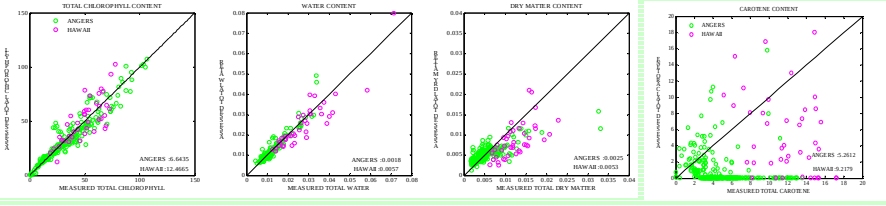


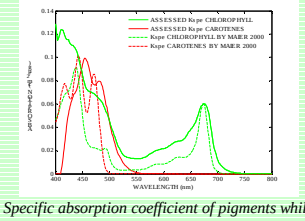




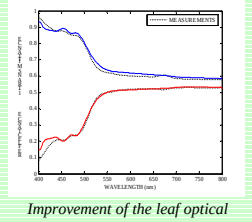
Specific absorption coefficient of pigments while retrieving only total chlorophyll

- Discrimination of total chlorophyll, carotenoids, water, and dry matter





Specific absorption coefficient of pigments while retrieving total chlorophyll and carotenoids



Improvement of the leaf optical properties in the VIS-NIR

5. Conclusion and perspectives

- *PROSPECT* has been significantly improved: the Kspe obtained agree well with the literature (Maier, 2000).
- Even if carotenoids are at present not accurately retrieved, their Kspe prove that pigments other than chlorophyll can be studied with *PROSPECT*.
- This study partly explains why the results for dry matter content have not been particularly successful.
- Further studies are required to better discriminate the pigment specific absorption coefficients and improve their estimation.