Inversion of PROSPECT-D

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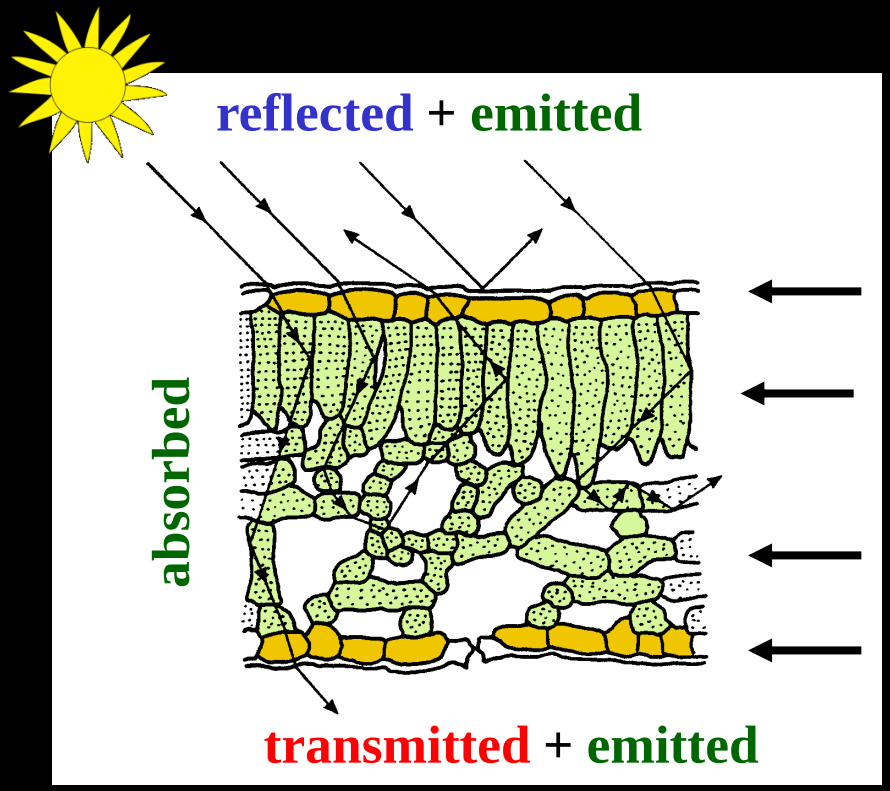
Leaf optical properties in the solar domain



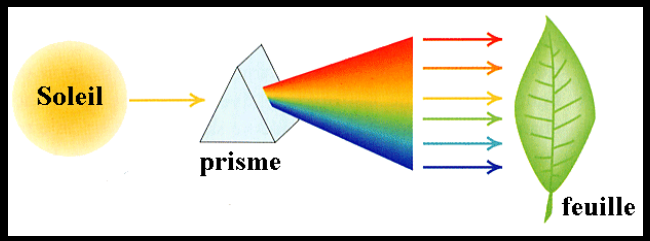
Surface/diffuse reflectance: $R = R_s + R_d$

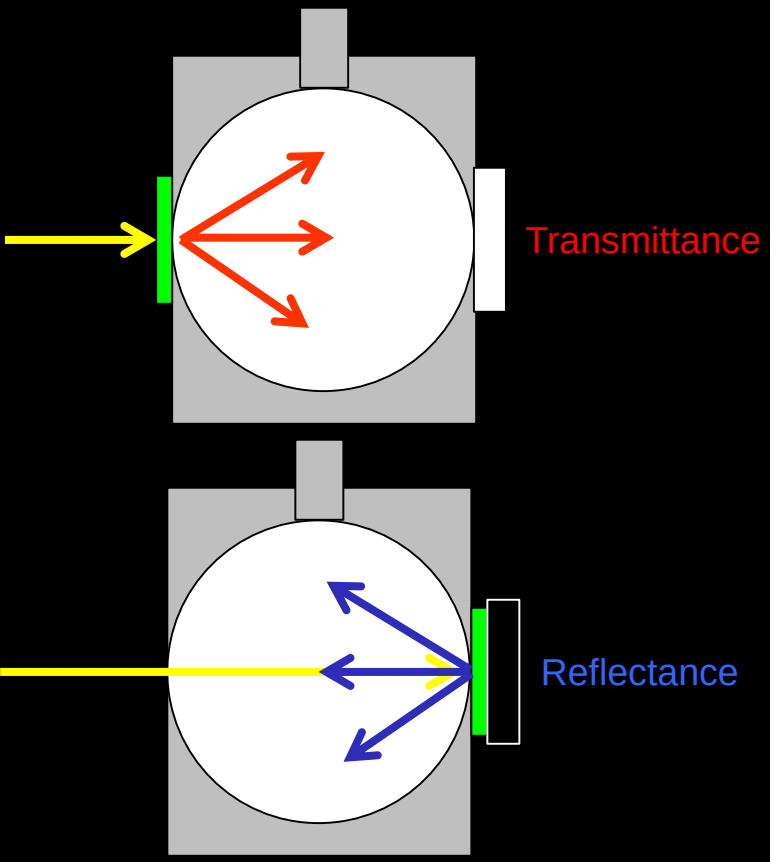
Kirchhoff's law: $A = \varepsilon$

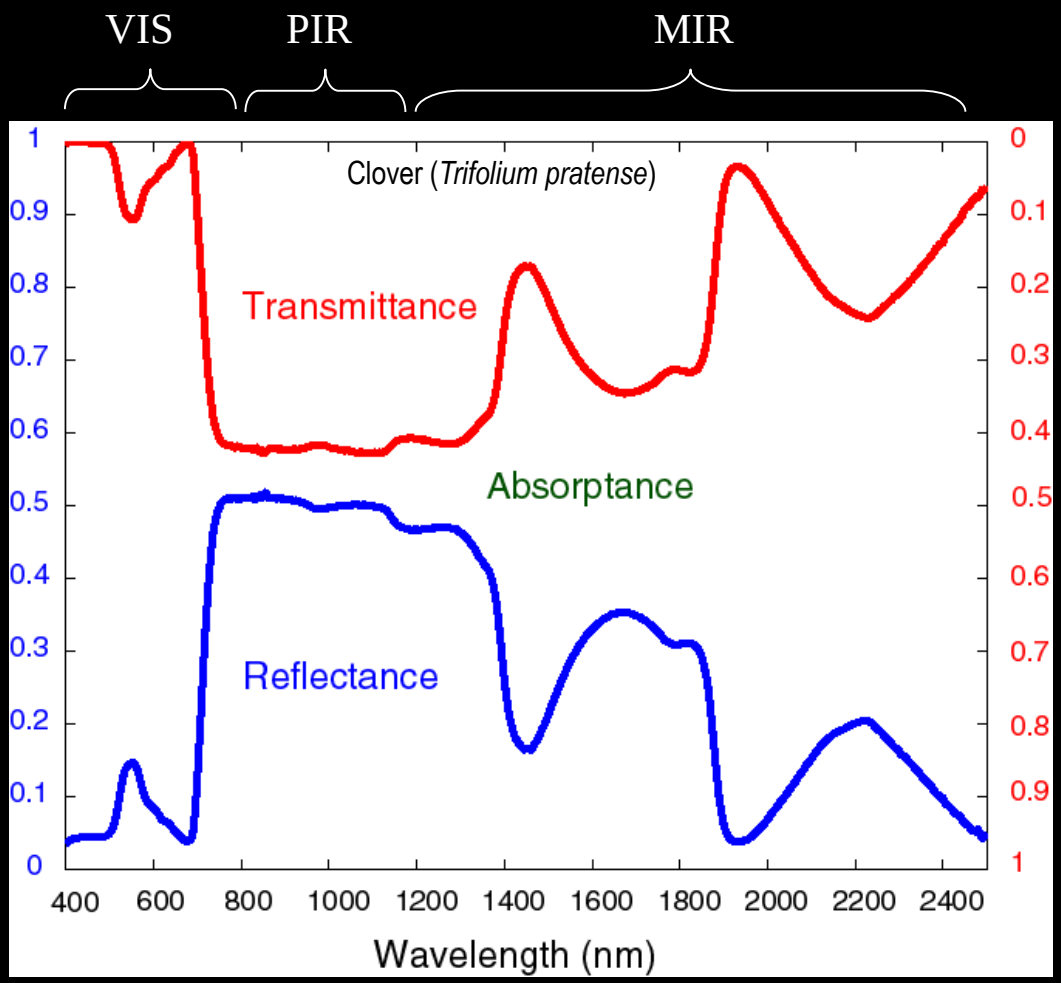
Conservation of energy: $R + A + T = 1$

Sinclair et al. (1973), *Agronomy Journal*, 65:276-283.

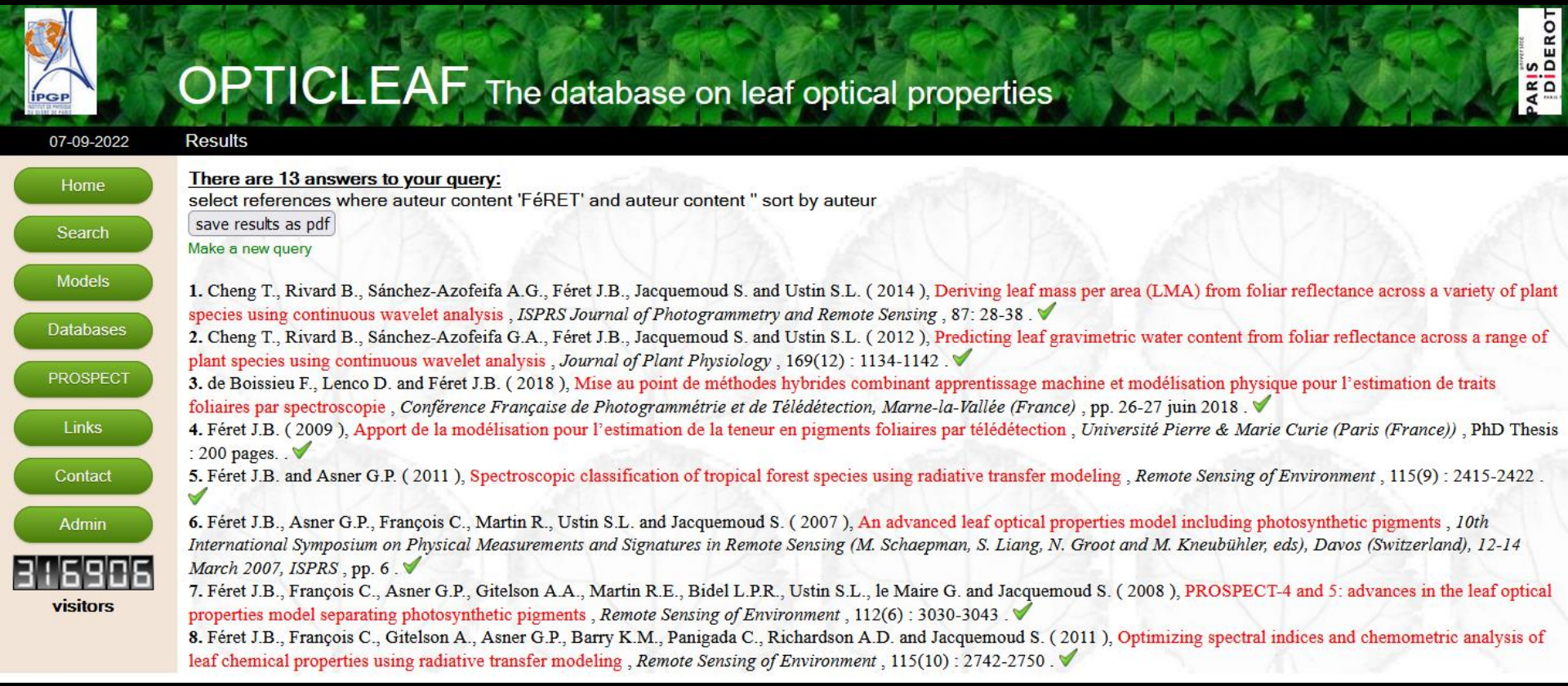
Leaf optical properties in the solar domain



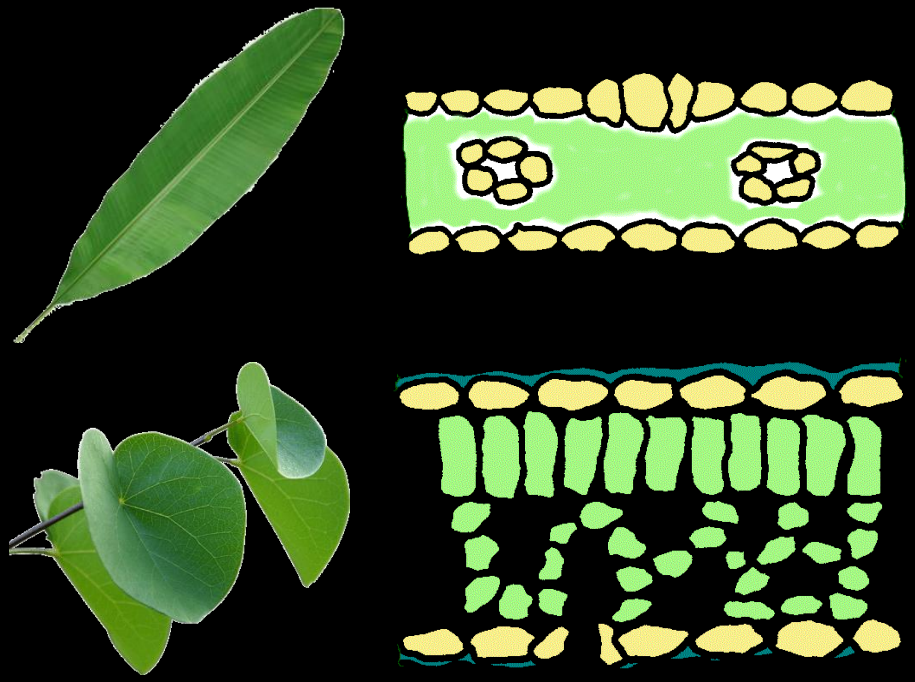


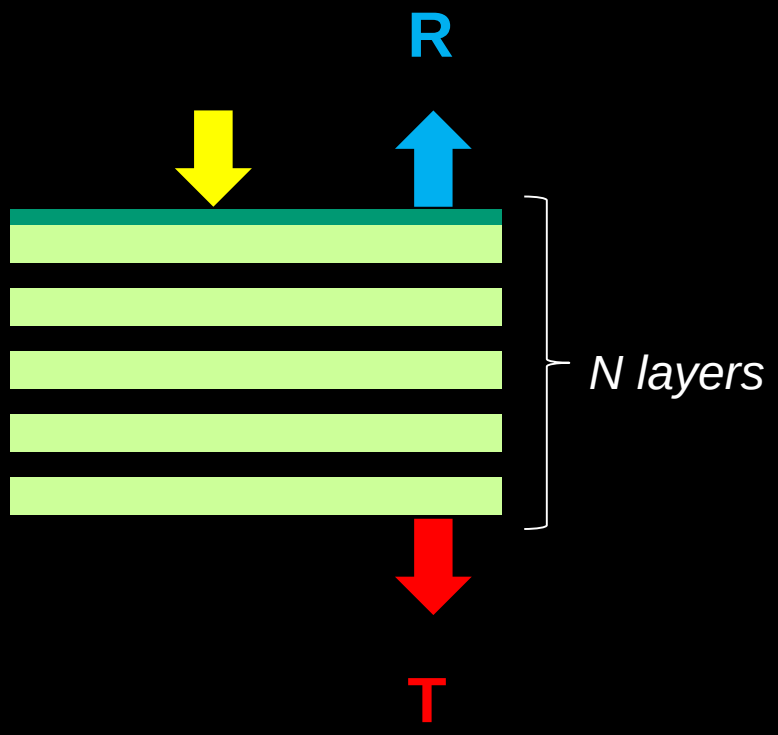


http://opticleaf.ipgp.fr/



PROSPECT: physical basis





Modeling leaf diffuse/directional reflectance/transmittance as a function of biochemical content and anatomical structure

- Surface optical properties: interface between two dielectrics (Fresnel equations)
- Volume optical properties: transmission through an elementary layer (Beer-Lambert law) and multiple reflections between N layers (Stokes system)

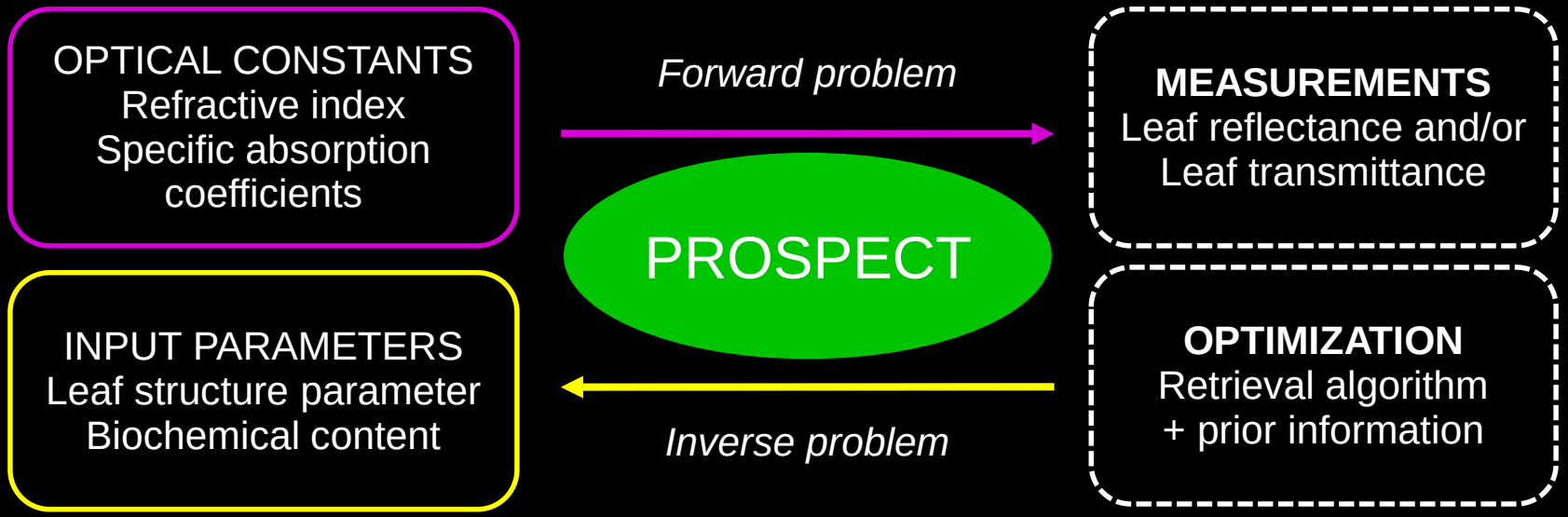
Allen et al. (1969), *Journal of the Optical Society of America*, 59:1376-1379.
Stokes (1862), *Proceedings of the Royal Society of London*, 11:545-556

PROSPECT: 30 years old

Plate model	1 layer (Allen et al., 1969)
Generalized plate model	N layers (Allen et al., 1970)
PROSPECT-3	N, C_{ab}, C_w (Jacquemoud & Baret, 1990)
	cellulose, hemicellulose, lignin, protein, starch (Fourty et al., 1996; Wang et al, 2015)
PROSPECT-4	N, C_{ab}, C_w, C_{dm} (Baret & Fourty, 1997) + brown pigments (Baret)
	improved specific absorption cofficients (Jacquemoud et al., 2005)
	adaptation to conifer needles (Zarco-Tejada et al., 2004; Malenovský et al., 2006)
	leaf BRDF/BTDF (Bousquet et al., 2005)
QSPECT	dorsiventral leaf (Ma et al., 2007)
DLM	dorsiventral leaf + epidermis (Stuckens et al., 2009)
PROSPECT-5	N, C_{ab}, C_{car}, C_w, C_{dm} (Féret et al., 2008)
FluorMODleaf	Chl fluorescence (Pedrós et al., 2010; Zhao et al., 2015)
PROSPECT-VISIR	extension to the SWIR (Gerber et al., 2011)
FLUSPECT	Chl fluorescence (Verhoef, 2011; Verrelst et al., 2015)
	extention to Cu absorption (Zhu et al., 2014)
PROCOSINE	PROSPECT-5 + leaf BRDF (Jay et al., 2016)
PROSPECT-D	N, C_{ab}, C_{car}, C_{anth}, C_w, C_{dm} (Féret et al., 2017)
PROSPECT-MP	N, C_a, C_b, C_{car}, C_{anth}, C_w, C_{dm} (Zhang et al., 2017)
PROSPECT-PRO	N, C_{ab}, C_{car}, C_{anth}, C_w, C_{pro}, C_{cbc} (Féret et al., 2021)

Jacquemoud & Ustin (2019), *Leaf Optical Properties*, Cambridge University Press, 566 pp.

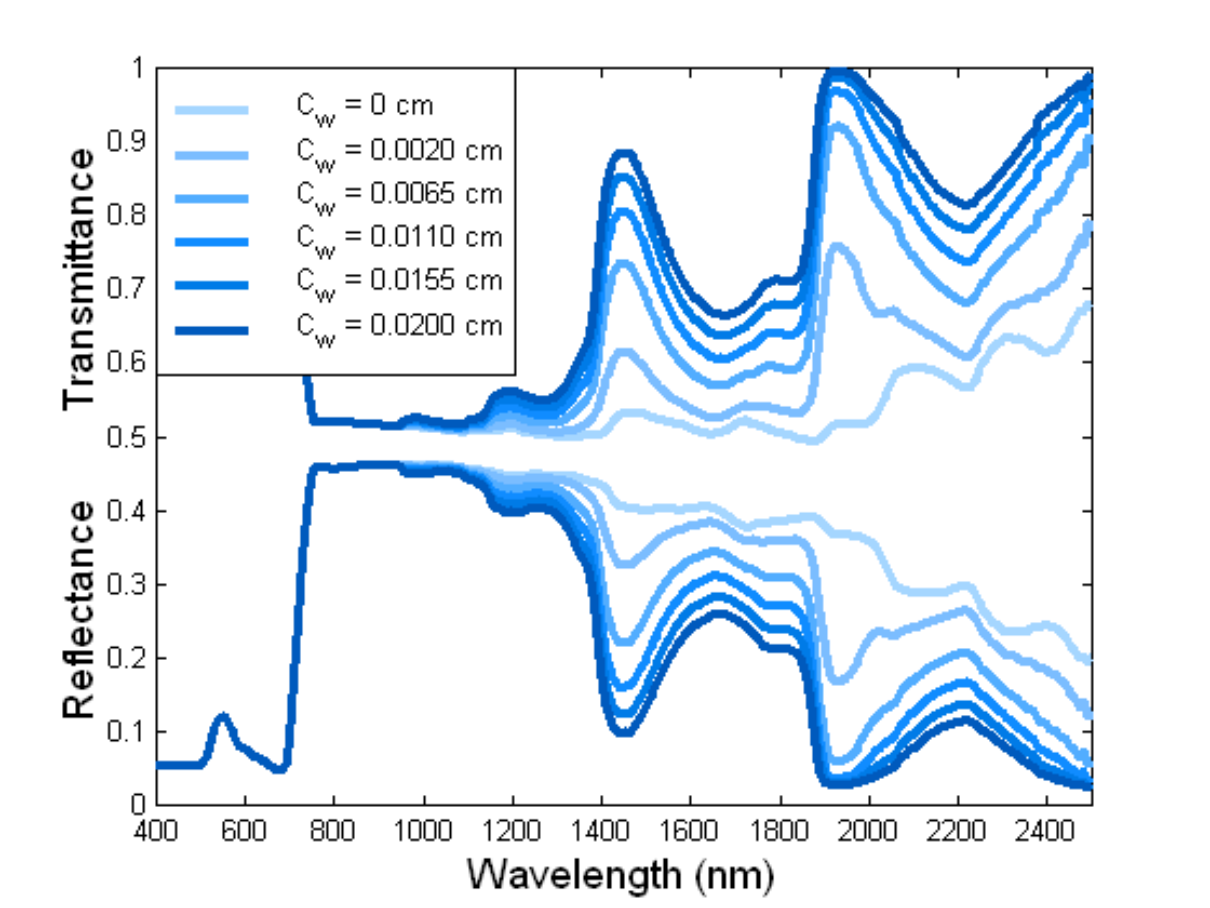
PROSPECT: direct vs inverse mode



Féret et al. (2008), *Remote Sensing of Environment*, 112:3030-3043.

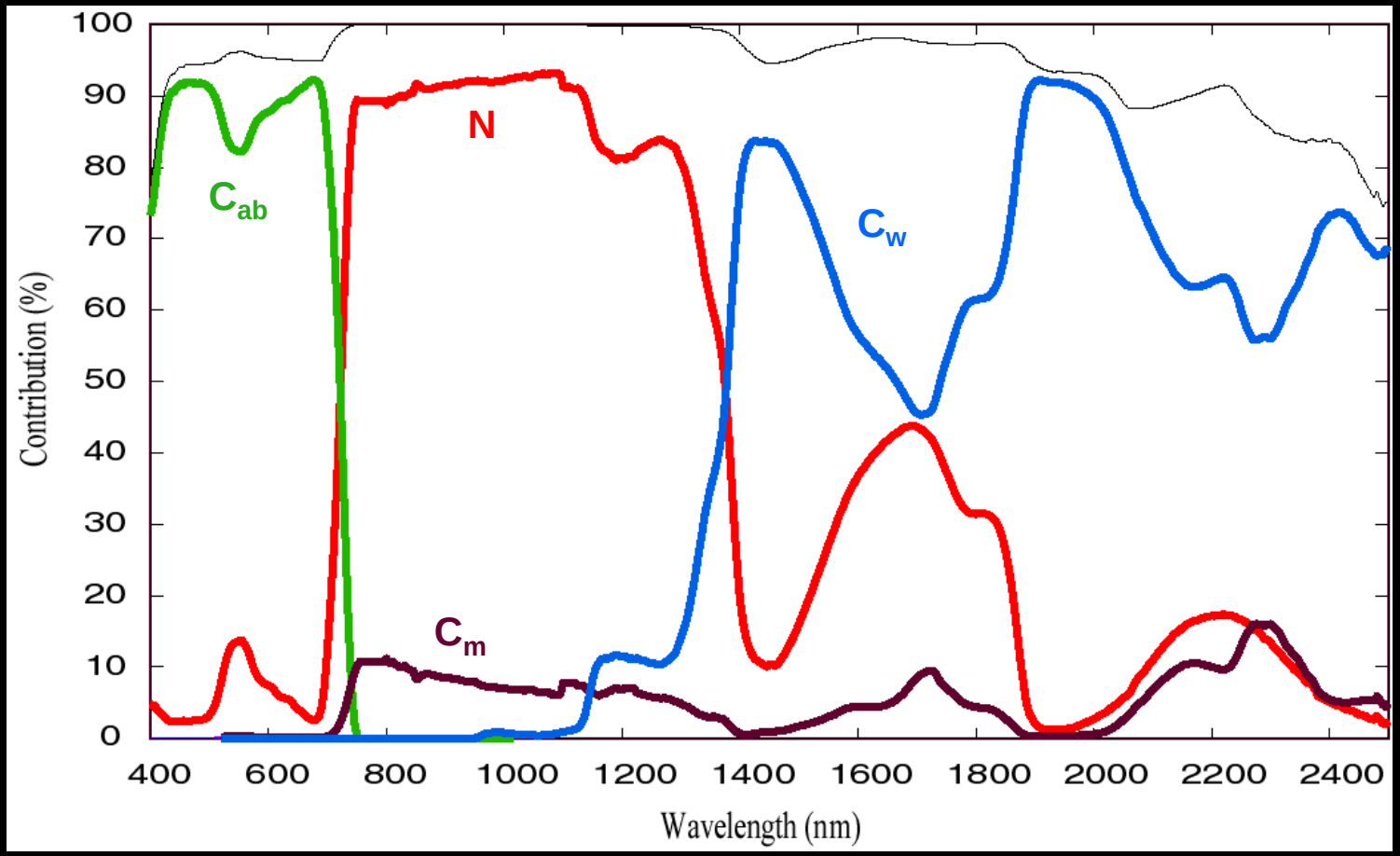
PROSPECT-4: one-factor-at-a-time sensitivity analysis

N = 1.5, C_{ab} = 50 µg.cm^{-2}, C_m = 0.005 g.cm^{-2}



PROSPECT-4: global sensitivity analysis

Contribution to leaf transmittance



http://teledetection.ipgp.fr/prosail/

PROSPECT, SAIL, and other RT models

Page updated on September 6, 2022

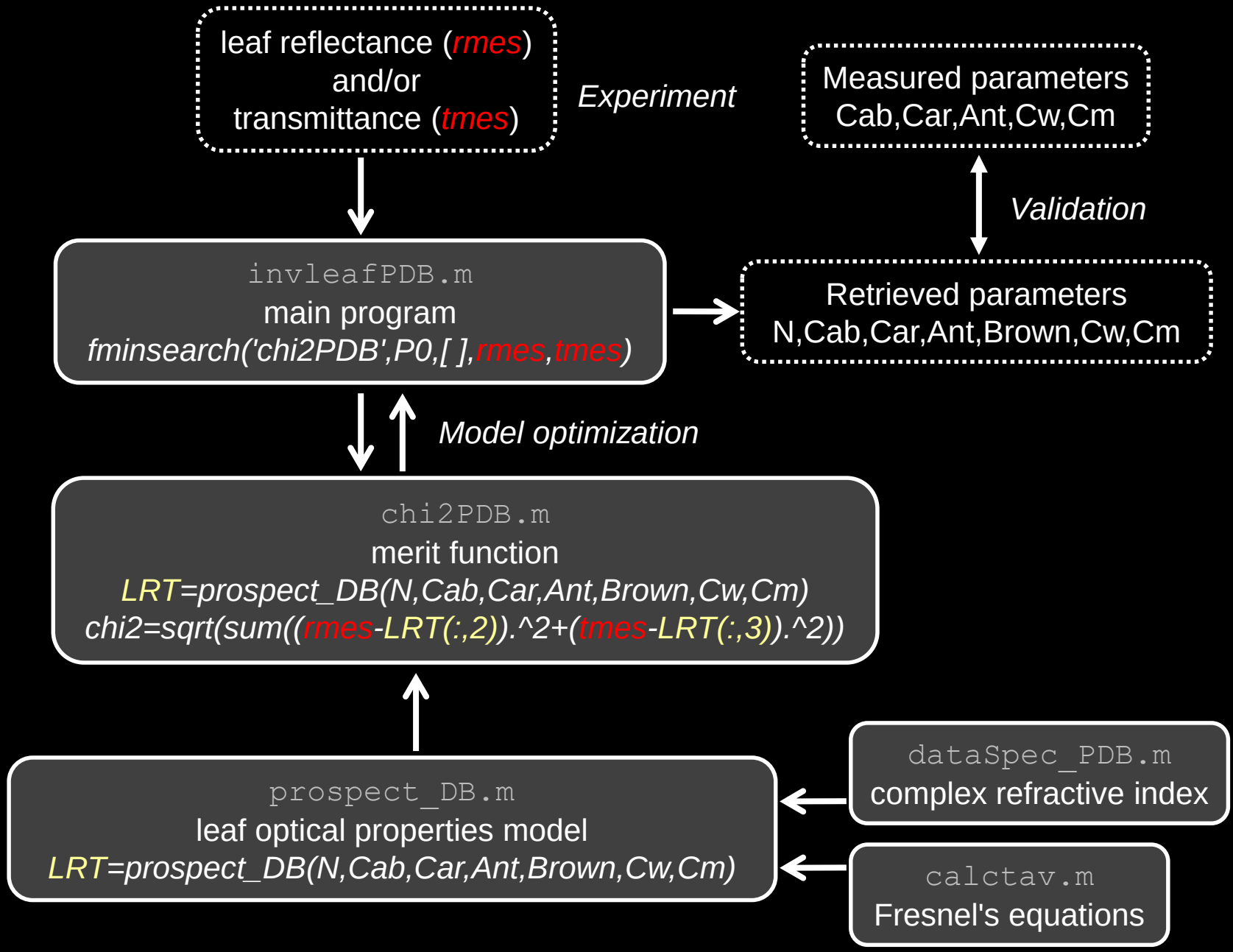
The PROSAIL model, a fusion of PROSPECT (leaf reflectance and transmittance) and SAIL (plant canopy reflectance), has been used for the last thirty years to simulate the spectral and directional reflectance of plant canopies in the solar domain. It links the spectral dimension of the reflectance, which is mainly related to the biochemical content of the leaves, to the directional dimension, which is mainly related to the architecture of the canopy. PROSAIL has been widely used to develop new methods to retrieve biophysical properties of vegetation and to prepare new space missions. Applications are numerous in agriculture, forestry, ecology, climatology, exobiology, etc. Because of its ease of use, robustness and regular updates, PROSAIL has become one of the most popular tools for radiative transfer in vegetation.

Version	Matlab	Fortran	IDL	Python	R	Web interface	GUI
PROSPECT-4	PROSPECT4_Matlab.rar	PROSPECT4_Fortran.rar					
+ SAIL							ARTMO
PROSPECT-5 *	PROSPECT5_Matlab.rar	PROSPECT5_Fortran.rar				PROSPECT5	
+ 4SAIL *	PROSAIL_5B_Matlab.rar	PROSAIL_5B_Fortran.rar	PROSAIL_5B_IDL.zip	PyProSAIL	HSDAR		ARTMO
PROCOSINE	Toolbox_Cosine.rar						
PROSPECT-D	PROSPECT-D_Matlab.rar	PROSPECT-D_Fortran.rar			GITLAB		
+ 4SAIL	PROSAIL_D_Matlab.rar	PROSAIL_D_Fortran.zip		PROSAIL-2.0.alpha	GITLAB		ARTMO
PROSPECT-PRO	GITLAB				GITLAB		
+ 4SAIL					GITLAB		ARTMO

* It is recommended to use PROSPECT-D (with zero anthocyanin concentration) rather than PROSPECT-5.

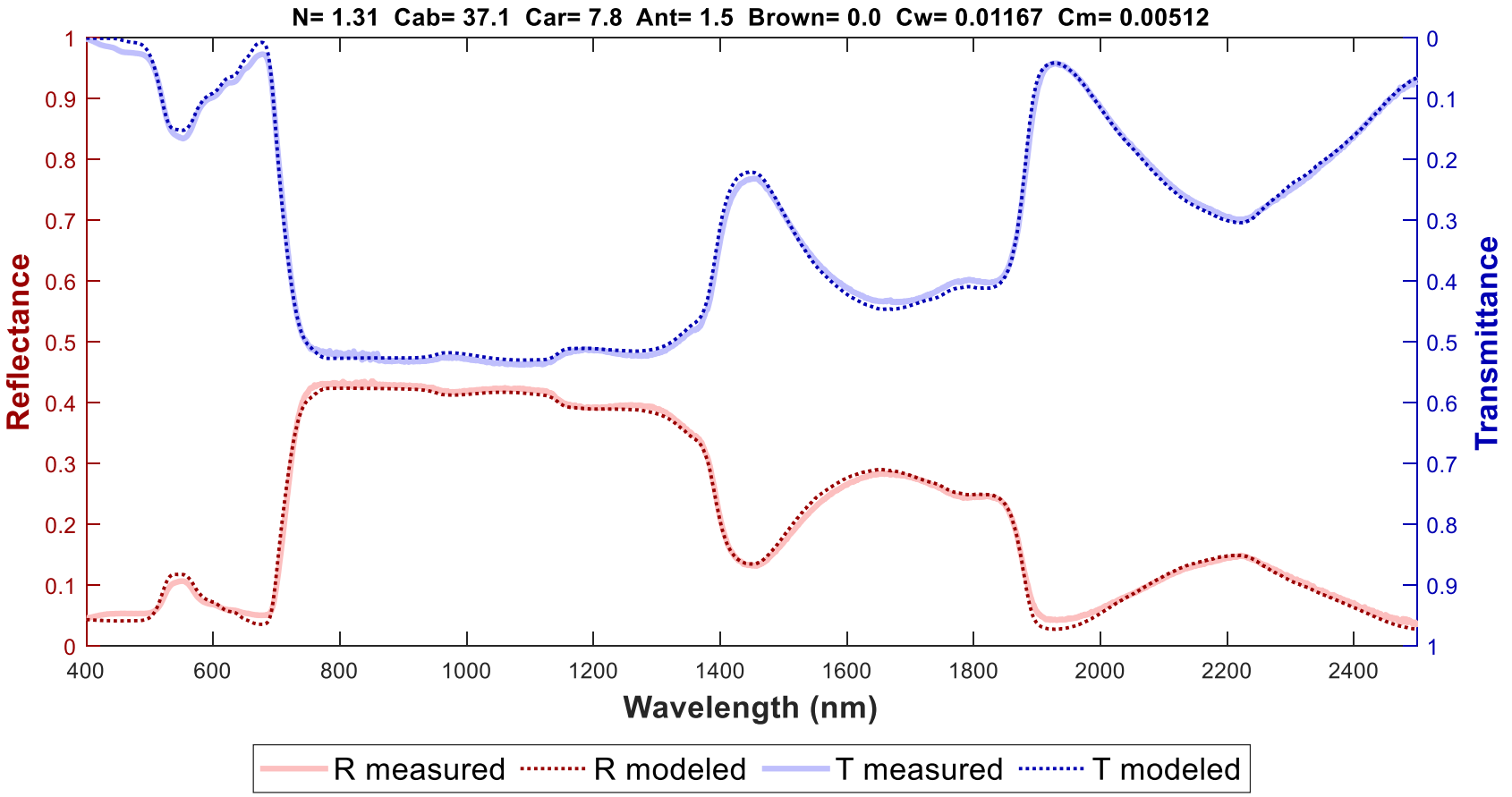
Download the Matlab files at http://teledetection.ipgp.fr/prosail/PROSPECTD_Matlab_inversion.rar

PROSPECT-D: inverse mode



PROSPECT: leaf reflectance/transmittance reconstruction

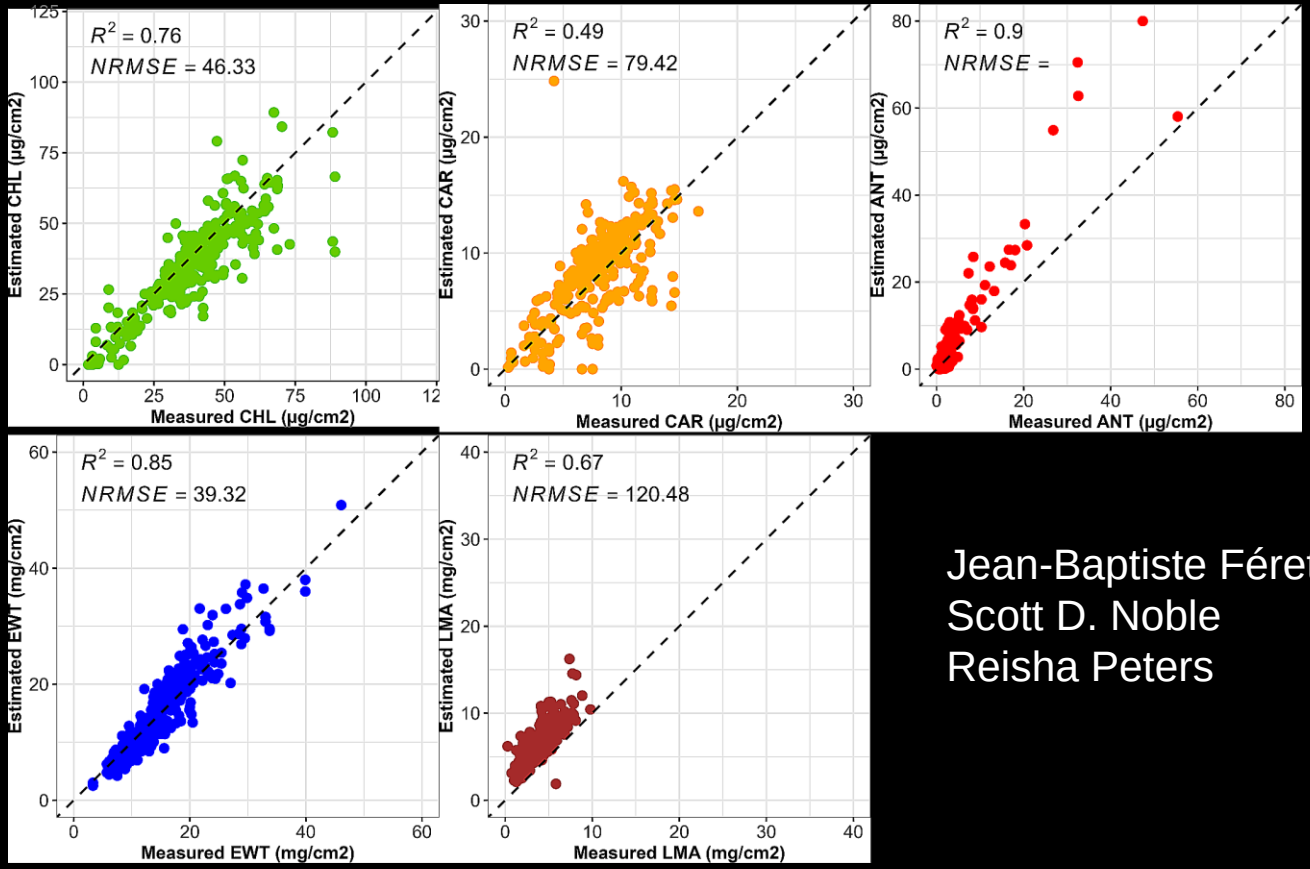
Poplar (*Liriodendron tulipifera*)



PROSPECT-D: leaf parameter retrieval

Thousands of leaf samples belonging to more than 100 plant species and corresponding to independent data sets acquired under various environmental conditions:

- climate: temperate, tropical
- ecosystem: forest, crops



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https://hdl.handle.net/10388/14061