RETRIEVAL OF BIOPHYSICAL PARAMETERS WITH AVIRIS AND ISM - THE LANDES FOREST, SOUTH WEST FRANCE -

Zagolski F.,Gastellu-Etchegorry J.P., Mougin E., Giordano G.,
Marty G., Le Toan T., Beaudoin A.

Centre d'Etude Spatiale Des Rayonnements Université Paul Sabatier, Toulouse.

I. Introduction

This paper presents the first steps of an experiment for investigating the capability of airborne spectrometer data for retrieval of biophysical parameters of vegetation, especially water conditions. AVIRIS and ISM (Table 1) data were acquired in the frame of the 1991 NASA/JPL and CNES campaigns on the Landes, South west France, a large and flat forest area with mainly maritime pines (Le Toan et al., 1991). In-situ measurements were completed at that time; i.e reflectance spectra, atmospheric profiles, sampling for further laboratory analyses of elements concentrations (lignin, water, cellulose, nitrogen,...). All information was integrated in an already existing data base (age, LAI, DBH, understory cover,...). A methodology was designed for (1) obtaining geometrically and atmospherically corrected reflectance data, for (2) registrating all available information, and (3) for analyzing these multi-source informations. Our objective is to conduct comparative studies with simulation reflectance models, and to improve these models, especially in the MIR.

II. Methodology and preliminary results

High resolution reflectance spectra obtained under different experimental configurations (in-situ, laboratory, and remote sensing) are retrieved and compared (Fig. 1).

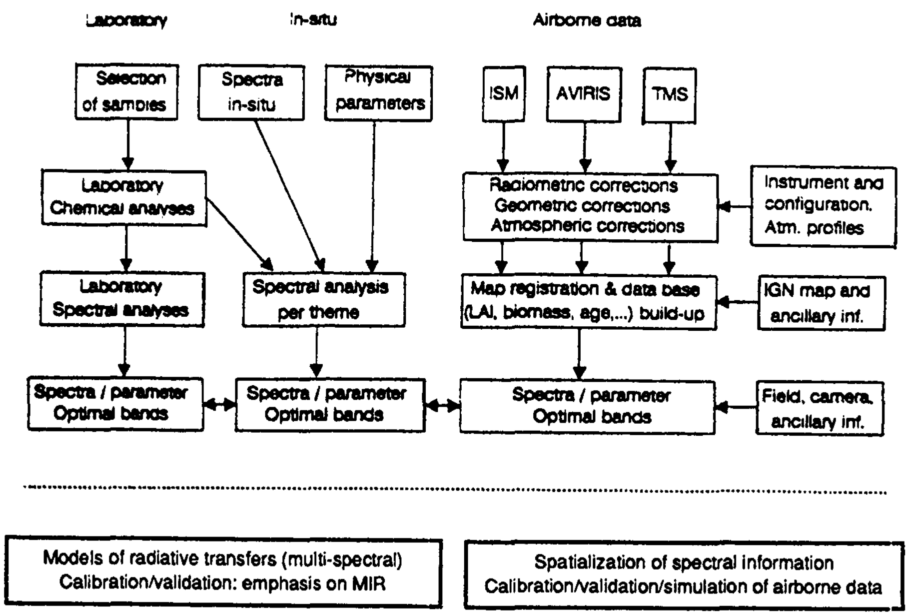


Figure 1: Schematic presentation of the methodology.

- laboratory: spectral analyses (19 bands from 1445 to 2348nm) to assess most valuable wavelengths for biochemical elements of vegetation (dry powder). Stepwise analyses showed that middle infrared bands are mostly efficient (Zagolski et al., 1992).
- in-situ: directional reflectance spectra are displayed on figure 2.
- low to medium altitude (very large to large scale): ISM surveys (Fig. 3) at 700m, 1000m, 2000m and 3000m altitudes, and with different configurations (Zagolski et al., 1992).
- high altitude (medium scale): AVIRIS derived spectral reflectances (Fig. 3) are encouraging in the way they show important differences for different age classes (biomass) of pine stands (Gastellu-Etchegorry, 1991).

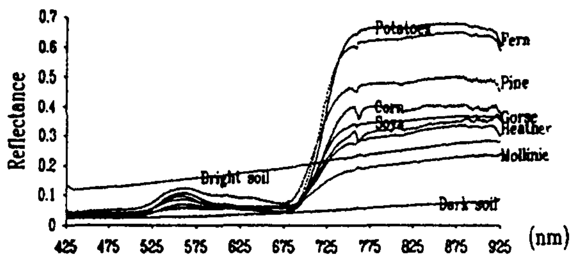
Retrieval of biophysical parameters is based on intercalibrated high resolution reflectance spectra. Preliminary steps to obtain these spectra are presented below.

* <u>Radiometric corrections</u>:

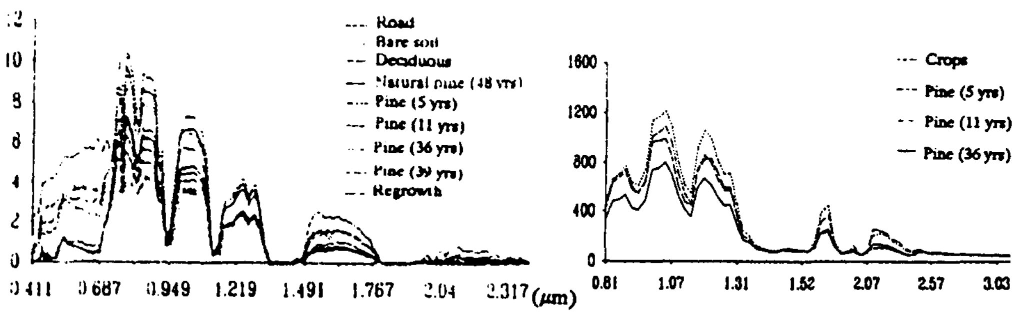
- AVIRIS digital counts were transformed into radiance values by calibration coefficients.
- Calibration procedures are being implemented for correction of ISM data.

* <u>Geometric corrections</u>:

- AVIRIS: only corrections of panoramic effects were applied.
- ISM: because surveys took place at low altitude levels geometric corrections are absolutely necessary. These corrections are currently being applied.



<u>Figure 2</u> : Directional reflectance spectra measured in the field.



<u>Figure 3</u>: AVIRIS reflectance spectra. ISM radiance spectra.

* <u>Atmospheric corrections</u>:

Systematic atmospheric correction of airborne data (Fig. 4), with the inversion of 5S atmospheric model (Tanré et al., 1990), leads to apparent reflectances ρ^*. A Gauss Seidel based iterative approach leads to convergence with only 5 iterations.

$$\rho^*(\theta_s,\theta_v,\phi_v) = \rho_a + \rho^*_c + \rho^*_e = \rho_a(\theta_s,\theta_v,\phi_v) + [\rho_c . \frac{T(\theta_s)}{1-\rho_e S} . e^{-\tau/\mu_s} + \rho_e . \frac{T(\theta_s)}{1-\rho_e S} . t_d(\theta_v)].T_{gas}$$

with ρ_a: intrinsic atmospheric reflectance,

ρ^*_c: "direct" apparent reflectance, partly due to the environment,

ρ^*_e: environment contribution (atm. condition = = > neighborhood of radius 50),

s and v: for sun and viewing angles, μ_s = cosine(sun zenith angle),

τ, S, E_s: atmospheric optical depth and albedo, and sun constant,

$T(\theta_s)/t_d(\theta_v)$: total/diffuse transmission coefficients, independent of T_{gas}.

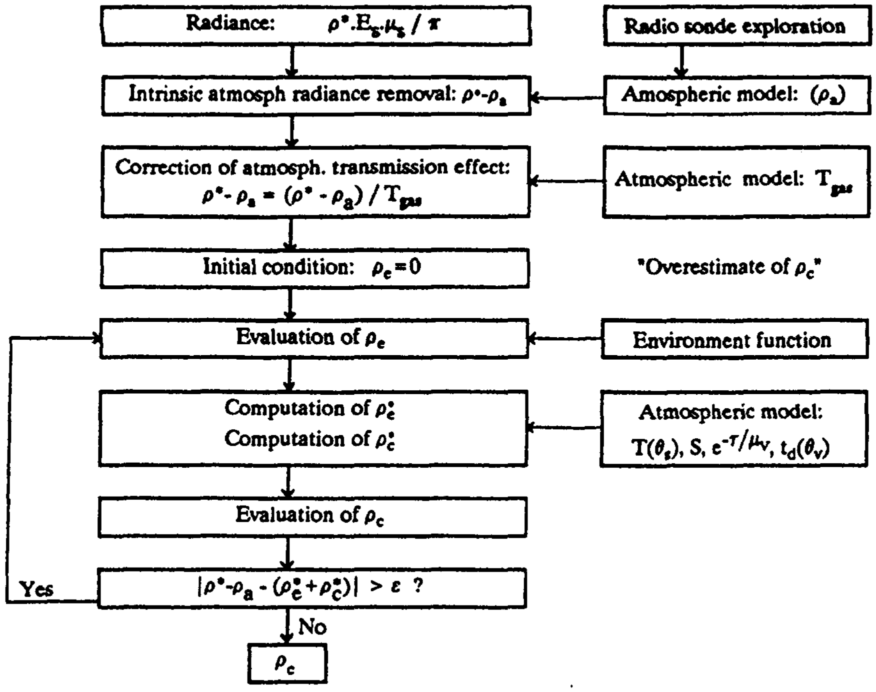


Figure 4: Atmospheric correction of AVIRIS images.

Table 1 :
ISM Operating parameters

- IFOV (entrance slit)	12' (transverse) / 40' (longitudinal)
- Detector	PbS cooled
- IFOV (Detector) / FOV (selectable)	8' x 8' / ±20°
- Scan unit / Scan rate (selectable)	1' / 341 Hz
- Swath width (at 6 km altitude)	#170 m (12 pixels)
- Spectral coverage: 1st / 2nd band	[0.8-1.6μm] / [1.6-3.2μm]
- Sampling interval: 1st / 2nd band	12.5nm / 25nm
- Number of spectral bands	128
- Digitalization	12 bits
- Integration time	30ms
- Signal/Noise	> 100
- Sun calibration	through optical fiber
- Internal calibration	light (several levels)
- Synchro video registration	Camera

IV. Concluding remarks

The 1991 NASA/JPL and CNES campaigns over The Landes test site provide a great opportunity for studying the potential of high spectral resolution for forest areas. Up to now, only basic processings were performed. Preliminary results already show the potential of high spectral resolution for discriminating different classes of vegetation. In a second step, once available information is calibrated and input into a data base, comparative analyses will be conducted for studying how those biophysical parameters that can be spectrally observed in the field and in laboratory can be assessed with airborne spectrometers at different altitude levels. The evolution of information at different spatial and spectral scales will be particularly considered. Our effort will concentrate on the explanation of results with the help of models.

References:

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Tanré D., Deroo C., Duhaut P., Merman M., Morcrette J.J., Perbos J. & Deschamps P.Y., 1990, Simulation of the Satellite Signal in the Solar Spectrum (5S), Manual, LOA pub.
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