VALERI-2000 campaign in Nezer site (France)

17 July - 10 August 2000

Dominique GUYON

Participants :

- Dominique Guyon, Gaston Courrier, Didier Garrigou, Jean Pierre Lagouarde, Jean Marc Bonnefond, Vincent Rivalland, Jérôme Lejot, Anne Marie Bouchon
  INRA Bioclimatologie, Bordeaux

- Jean Louis Roujean, Wim Van Leeuwen, Roselyne Lacaze, Laurent Franchisteguy et Karine Belin
  Météo France, CNRM, Toulouse

1. INTRODUCTION

The VALERI-2000 campaign took place from 17 July to 10 August 2000 in the test site called NEZER. The objectives are to obtain LAI and cover fraction estimates at low spatial resolution (1km² for instance) for validating large swath satellite products.

The site is located in the Landes forest which covers about 1 million hectares in the South West of France and where maritime pine (*Pinus pinaster* Ait.) is the dominant species.
The measurement period corresponds to the end of the growth of trees and of understorey vegetation i.e. to the phenological stage when the green LAI is almost maximal.

2. LOCATION AND DESCRIPTION OF THE TEST SITE

The test site is included into a 8km * 11km grid whose co-ordinates are given in table 1.

	Geographic co-ordinates (geodesic system: WGS84) Longitude ; Latitude	LAMBERT III co-ordinates (geodesic system: NTF) Easting ; Northing
Upper left corner	1°05.15’ W ; 44°37.20’ N	328000 m ; 3263000 m
Lower right corner	0°59.45’ W ; 44°34.14’ N	336000 m ; 3252000 m

Table 1: Co-ordinates of the 8x11km grid

The grid area is covered in major part by large and homogeneous (even-aged trees) stands of maritime pine which are intensively managed. The remainder consists mainly of small deciduous wood lands, mosaics of small-sized stands of deciduous species or pine, large agricultural fields, urban and industrial areas, and unmanaged heath lands (see the land use map in figure 1).

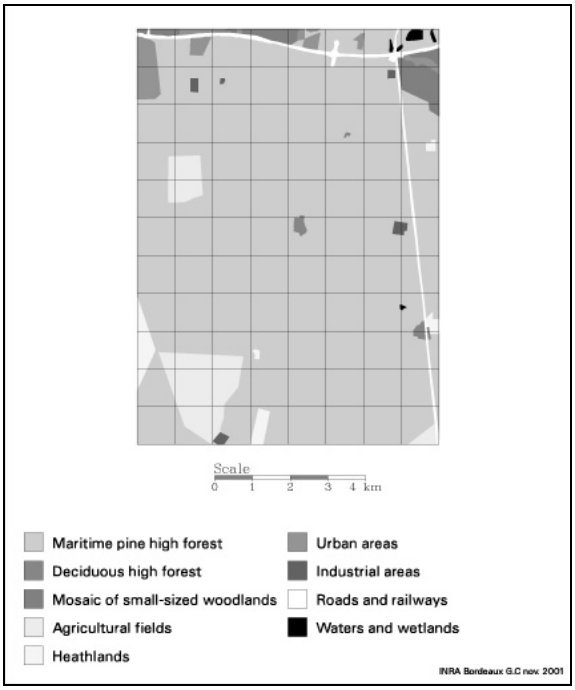


Figure 1: Land use map in 2000 (from aerial photographs and Spot images)

The Nezer site itself covers about 50 km² in the central part of the grid. It is a patchwork of large maritime pine stands whose mean size is about 500m x 500m and whose various stages of development are ranged from the sowing to the clear-cutting (at about 50 years). The forest structure is thus very heterogeneous at the scale of 1km²-units, where the proportion of surface not covered by trees, i.e. clear-cuts or young stands, ranges between 5% and 95% (Guyon et *al*., 2000).
The whole of maritime pine stands of the experimental site are described in geographic data base built by INRA (so-called INRA geographic data base), where age, some dendrometric characteristics and sylvicultural practices are given.

3. GROUND MEASUREMENTS OF LAI

- **Protocol of spatial sampling**

The big storm which occurred in December 1999 in France damaged many stands. Its consequences (windthrow, windbreakage, overgrowth of the understorey vegetation) have strongly constrained the sampling protocol and so did not make easy the ground measurements.
Information collected from the INRA geographic data base, aerial photographs at large scale (January 2000), SPOT images and ground observations about forest structure and accessibility is used then to optimise the spatial sampling.

- Selection and location of sampling plots

The sampled stands have been chosen in according of 5 criteria: (1) representativity of the distribution of age classes. The 5-to-15 years old stands are under-sampled because of their inaccessibility due to the overgrowth of the understorey. (2) size of the stand greater than 4 ha. The LAI estimation from LAI2000 instrument is indeed based on directional gap fraction measurements over a surface which can be very large. Its radius is roughly 3 times the canopy height. For instance the field of view of the sensor is about 120m for trees 20m high (3) regular spatial distribution in a grid of 1km² sub-areas (4) availability of forest data in the INRA database (5) accessibility.

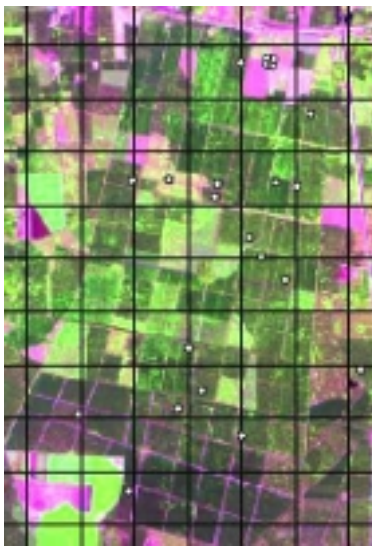


Figure 2: Location of sampling plots on the SPOT4 image (2000/08/01). The scale is given by the 1km²-grid.

The geographical location of the centre of each plot is obtained from ground measurements of distance and from the INRA geographic database. It is given in LAMBERT3 map projection. We did not use GPS system.

- Plot size and location of measurement points within plot

Two protocols are defined in according to the age of the stand. The first corresponds to the clear-cuts and young stands with trees lower than undergrowth vegetation. The second corresponds to the other age classes. In the case of the oldest stands the LAI is measured only for trees storey after removal of the windfall trees and clearing of the understorey.
The sampling designs are conceived to limit bias due to the tree spatial distribution by rows (Table 2, Figures 3 and 4). The points location is not measured.

Age class	Plot			Measurement points within the plot			Strata
	size (m)	Distance to stand edge	number	sampling	Number	Repetition /point	
Clear-cuts & Age < 5 years	20x20	≥40	6	Systematic (8 transects)	40	0	Understorey + trees
Age > 5 years	80*80	≥70	17	random	30	0	trees

Table 2: Plot size and sampling design within plots

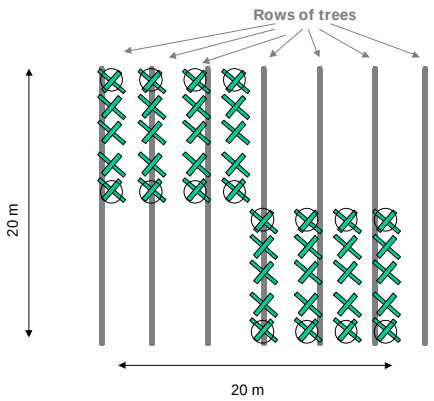
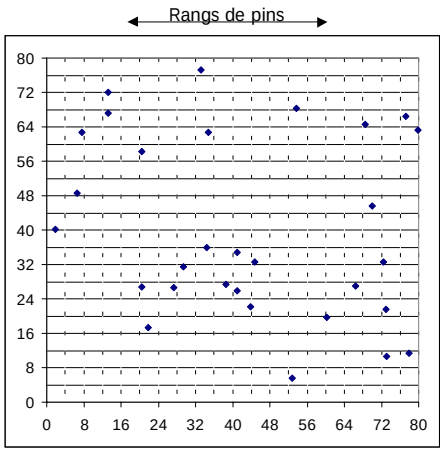


Figure 3: Sampling design (green crosses) within plot for young stands and clear-cuts.



Échantillonnage spatial aléatoire de 30 points de mesure sur une surface de 80m x 80m

Figure 4: Sampling design within plot for stands older than 5 years

- **Methods of measurement**

We have used LAI-2000 analysers (LI-COR Inc.) which provide gap fraction measurements in 5 classes of viewing direction. The zenith angles of each class are on average equal to 7, 23, 38, 53 and 68°.
Measurements are made in diffuse radiation conditions: clear sky at sunset or at sunrise when the sun is outside the field of view of the sensor (sun zenith angle >74°). They have been carried out between the 22th July and the 8th August.

Two methods are defined in according to the age of the trees:

- clear-cuts and young stands

Only one LAI-2000 system is used. The incoming illumination above the canopy is measured at the begin and at the end of each transect along trees rows (marked by circles in figure 3). The transmitted radiation below the canopy is measured at ground level under the understorey vegetation. The azimutal field of view of the sensor is reduced to 180° for hiding of the operator. The transects are covered with the sensor looking along the row.

- Stands older than 5 years

Two LAI-2000 systems are necessary. One is located in a large clear-cutted area and automatically records the incoming illumination above the canopy every 15 seconds. The other provides measurements below the pines canopy. Each sensor is horizontally set on a photographic tripod at shoulder height (about 1.5m). The azimutal sampling is total (360°). It is necessary to make measurement with uniform sky conditions, because the 2 sensors are often several kilometres apart. The method requires to calibrate the 2 sensors to each other.

We have used 3 analysers: only one (named VAL1) is used for remote measurements of incoming radiation, the 2 others (named VAL3 and UREFV) collect data below the canopy. Their calibration has been performed at the beginning of the VALERI experiment (17 and 24 July 2000) with clear sky conditions and for solar zenith angle greater than 82°. Results are given for each class of view zenith angle in figure 5.

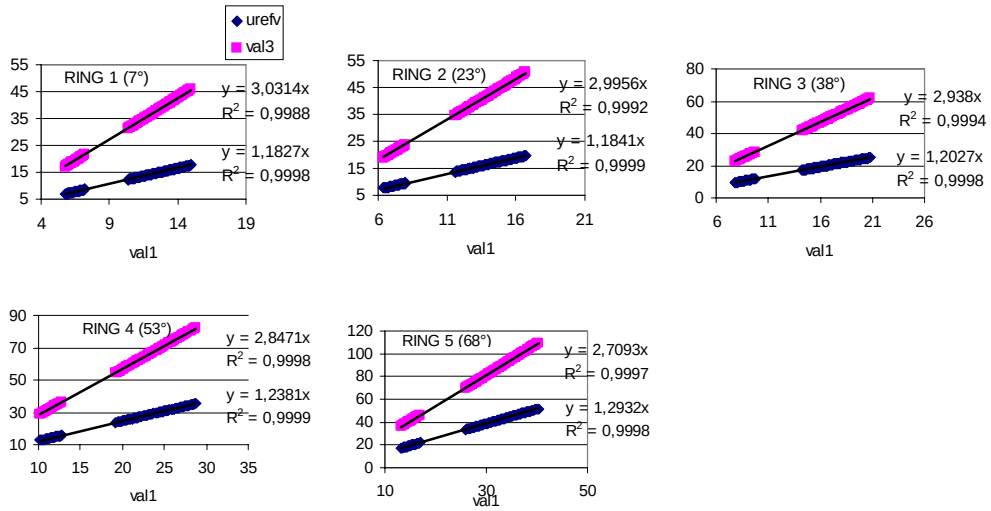


Figure 5: Inter-calibration of the 3 LAI-2000 sensors
VAL1 : serial number = PCH-0979
VAL3: serial number = PCH-1467
UREFV: serial number = PCH-0122

- **LAI estimation**

The LAI estimation from measurements of directional gap frequency assumes that the foliage is randomly distributed. We have ignored the clumping around stems and branches. The retrieved values correspond thus to the effective LAI. The computation is made with the C2000 software devoted to LAI2000 data processing.

The used radiation interception model and the inversion method are described in the report on VALERI-2000 campaign for Romilly site.

4. ATMOSPHERIC AND RADIATIVE FLUXES MEASUREMENTS

Various kinds of data have been measured at ground or collected for atmospheric correction of satellites data acquired during the campaign.

- Atmospheric transmission of direct sun radiation

Manual sunphotometer (CIMEL CE318) is used to estimate aerosol optical thickness with the Langley-Bouguer method (Wu et *al*., 1997). The atmospheric optical properties are measured at various wavelengths: 440, 670, 870, 936, 940 and 1020 nm. The instrument is set close by the BF2 instrument (see below).

Two types of measurements have been performed:

- For calibration of the Langley-Bouguer method: measurements are made from sunrise to sunset in conditions of clear sky and stable atmosphere. We have obtained satisfactory data sets for 3 days (days 202, 213, 222), except early in the morning because of haze or smoke plume coming from a neighbouring paper factory. The frequency of measurement depends on the sun zenith angle: from 2 minutes at beginning and at end of the day to 10 minutes at midday.
- For estimation of aerosols during acquisitions of SPOT satellites data : measurements are made between 10 to 12 UTH. Data have been recorded for 5 days.

- global and diffuse incoming radiation

An integrated sensor of photosynthetic active radiation (400-700nm) is set in a large clear-cutted area located in the central part of NEZER (331592m Easting, 3259485m Northing Lambert3). The instrument named BF2 (Delta-T Devices Ltd) is used to measure global and diffuse incoming radiation.

Measurements are recorded from 17 July to 10 August 2000 (figure 6). From 10 to 17 July the sampling frequency is equal to 10 minutes. After 17 July the measurements are made every 2s and averaged every 1 minute. In this case instantaneous data are not recorded.

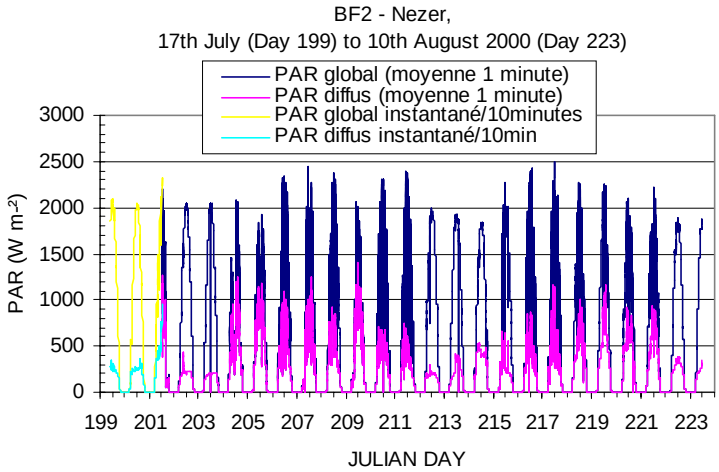


Figure 6: Incoming PAR measured from 17 July to 10 August 2000

- Complementary atmospheric data are also provided by METEO-FRANCE: sea level pressure and vapour water content from the ARPEGE meteorological meso-scale model and ozone content from TOVS/NOAA measurements. They are complemented by ground-based measurements of sea level pressure on the EUROFLUX/INRA experimental site located at about 25km from Nezer.

5. SPOT IMAGES

Two SPOT4 multi-spectral images were acquired during the campaign: 20 July and 01 August 2000. They are georeferenced in the LAMBERT3 map projection from geometric corrections processed by SPOT IMAGE company.
We did not make any sun photometer measurement on the 1th August because of the variable weather.

6. DATA FILES DESCRIPTION

The data files are described in the file named *datafiles_description.txt*

7. CONCLUSION

The experiment lasted 3 weeks because of bad weather.
Only 22 forest stands are been sampled in the 50km² study area. The main reasons of the low sampling are the following:

- LAI2000 measurements require uniform sky brightness. Blue sky conditions at the sunrise or at sunset were satisfactory for a little number of days. Conditions of uniform overcast sky have never been observed during any day of the period, except for rainy weather.
- Dew or fog at morning have reduced the measurement capabilities.
- Inaccessibility due to windstorm damages or high density of the understorey vegetation

In the framework of VALERI the LAI2000 measurements should be performed at ground level, including both tree crowns and understorey. It is the case only for young stands and clear cutted areas. For the oldest stands data were acquired only for tree crowns, because of the presence of broken crowns or windfall trees on the ground or because of the difficulties to progress in the very tall and dense vegetation of the understorey.
For future VALERI experiments the sampling strategy should be reviewed. It is better that the size of plots and the number of measurement points per plot are not variable. The size of study area should be also reduced.

8. BIBLIOGRAPHY

GUYON D., DUCHEMIN B., LAGOUARDE J.P., BERBIGIER P., 2000. Monitoring of forest ecosystems at regional scale using VEGETATION daily-data : First results on the Landes maritime pine forest (SW France). Proceedings Séminaire VEGETATION 2000, Belgirate (Italy), 3-7 April 2000. 119-125

WU D., YIN Y., WANG Z., GU X., VERBRUGGHE M., GUYOT G., 1997: Radiometric characterisation of Dunhuang satellite calibration test site (China). Proceedings of the 7th international symposiun Remote Sensing “Physical measurements and signatures in Remote Sensing”, Couchevel France, 7-11 April 1997. Guyot & Phulpin Editors. 1997 Balkema, Rotterdam..151-160.