REPORT ON VALERI ESTONIAN CAMPAIGN
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A] Location and description of the test area

This Valeri test site is located in the so-called forest of Järvselja, in the eastern part of Estonia. It corresponds to a 10 km x 10 km square, centered at the geographical coordinates 58°15'N - 27°28'E, corresponding more or less to the POLDER pixel in this area. The location of the test site is shown in the following maps (figure 1). In 2001, a 3x3 km sub-area was chosen for the LAI-campaign.

This area is mostly covered by a sub-boreal mixed forest, including both conifers (Scots pine and Norway spruce) and deciduous (birch, aspen, alder). Agricultural fields were almost missing on the 3x3km region, however, a few unmanaged open areas are found. At the south-east and north-east extremities, some bogs and mires (peatland) are taking place. The whole "pixel" is thus very heterogeneous at first sight.

Figure 1: Localisation of the Järvselja Estonian site

B] Sampling protocol and measurement plots selection.

The area sampling is based on a non-supervised classification out of a Landsat image acquired on 10.07.99. A posteriori interpretation achieved by the Estonian team with data base and field observation led to the extraction of sixteen dominant classes (cf. figure 2). In each of these classes, several candidates are selected in relation with existent ancillary data in the forestry data base (species fractional distribution, age, understorey description, height and width of trunks, management practices…), and also taking into account the accessibility of the parcels. These candidates are also chosen so that they are spread all over the area to maximize the spatial sampling of the field data collection.

Figure 2: Classification of the Järvselja site from Landsat, 10.07.1999.

The center of the plot (CP) is selected as close as possible to the center of the parcel, in an homogeneous area. This CP is then located by a GPS measurement.
All the GPS positions are given in the "Position.txt" file. Most of them (42 plots) have been post-processed with differential data provided by Tartu fix station, and are marked in the file with a 1 in column "dif". This allow a precision of about one meter for the corrected positions, and about 10 meters for the others. These data are georeferenced in LAMBERT-EST projection (Lambert Conformal Conic 2 parallel) described in table 1.

Datum	ETRS-89(GRS-80)
1st Standard Parallel	58°00'N
2nd Standard Parallel	59°20'N
Central Meridian	24°00'00''E
Coordinates of Origin	57°31'03.19415''N , 24°00'E
False northing	6375 000 m
False easting :	500 000 m

Table 1: Description of Lambert-Est projection characteristics.

C] Protocol of measurement in a given plot, and abbreviations used in this document.

The same LAI measurement protocol is drawn for almost each forest plot.
On each of the 1x1km sub-area, at least 3 stands were chosen for measurements. A preliminary choice of the measurement stands was made according to the existing forestry database of the region, to guarantee more or less adequate representativity of different forest types. The region is divided into more or less homogeneous forest parcels – stands. Each stand has a code number according to the forestry database. The code number consists of two parts: large compartment number and smaller parcel number. Such as number 225_05 means that the large compartment number is 225 and stand number 5. With these numbers, the stands can be identified, and the forestry data extracted from the respective forestry database. Also, stand borders as digital vector files can be identified with the similar number (e.g. 22505) and the respective borderlines superimposed on georeferenced raster images (see).

Due to extremely difficult weather conditions just before the measurement series (non-typical heavy rains for that season), some of the preselected stands were inaccessible. For that reason, new more easily accessible stands were chosen instead. Location of the sample plots for the measurements can be seen on the SPOT image of the region (see).
Measurements were made at 5m, 10m and 15m distances from the center of the plot (CP) in each geographic direction, in the fixed sequence N-S-E-W. At each point, 4 records were made. In total, on a sample plot 3x4x4 = 48 LAI readings were taken.
One record consisted of a measurement below the understorey (at the ground level) plus one at the shoulder level (mode G+S). So, on each plot 48 readings were taken at the ground level and 48 at the shoulder level. The sensor was partly screened with the 180° mask, and always oriented with the sun in the back of the operator.
The reference measurements (above canopy) were acquired in an automatic procedure (each 30s) by a LAImeter displayed in an open area close to the measured plots. The reference sensor in the open was also screened and oriented away from the sun direction. The LAImeters have been intercalibrated and the given files provide operational data, which means intercalibrated and mixed below/above canopy records.

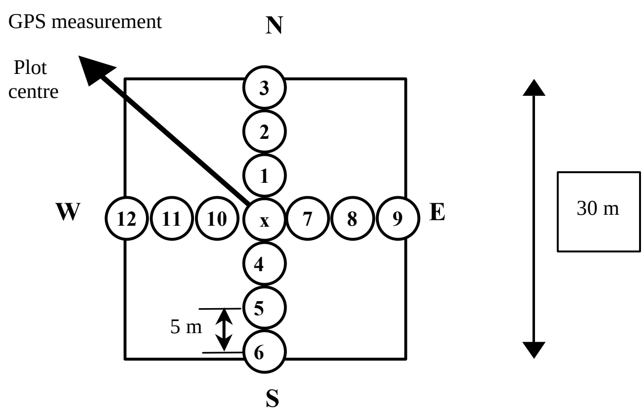

Figure 3: Schematic representation of plot measurement protocol

Another series of measurements was conducted on so-called ‘large cross’. As the centre of the cross, the centre of the 3x3 km region served. First of all, the GPS coordinates of the centre were found. Measurement points were set at each 50m, i.e. at 50m, 100m, 150m, 200m, 250m, 300m, 350m, 400m, 450m and 500m from the centre to N, S, E, and W directions. All points were located by a 50m measuring tape and compass and marked. Afterwards, the GPS coordinates of all points were measured. Four LAI-2000 measurements were made at each point at the ground level and four at shoulder level.

D] Atmospheric correction of SPOT images

The atmospheric correction of SPOT images was made by using the 6S package (Tanre et al., 199). First, the DN-s of the images were transformed into satellite-level radiance units by means of SPOT sensors calibration data containing in the auxiliary files of the images. Since no sunphotometer data were available in Estonia, we had to use indirect methods to determine the needed atmospheric data. Some of the input data we estimated from measurements, like the ozon amount from the TOMS data. Water vapour was estimated via a linear regression of total water vapour content on ground-measured absolute humidity (partial water vapour pressure, hPa) derived for Estonia (Okulov et al. 2001). Aerosols are the weakest part of the procedure. We assumed that certain dark objects (a selection of spruce forests) had a given ground-level reflectance factor in the red band (xs2) The reflectance factor of spruce forests was calculated by our forest reflectance model (Kuusk and Nilson, 2000) depending on the sun angle and to some extent on phenology at the moment of acquiring the image. We assumed that the lacking radiance signal in the red band was caused by aerosol, and thus its amount was estimated. The adjacency effect was neglected, so a linear relation between digital numbers of the image (DN) and ground-level reflectance factors (RF) was obtained:

RF= b DN + a.

The procedure resulted in the following relations:

SPOT2 image of 25 June 2001:

Band	Slope b	Intercept a
XS1	0.002471	-0.0776
XS2	0.002620	-0.0398
XS3	0.003031	-0.0285

SPOT4 image of 4 July 2001

Band	Slope b	Intercept a
XS1	0.000805	-0.0515
XS2	0.000694	-0.0244
XS3	0.002254	-0.0109
XS4	0.001615	-0.0008

Raw Data: file names and format (directory RawData0)

File: Summary_data.xls

Gap fraction data are given as averaged over all measurements on the same plot on zenith angle rings 7, 23, 38, 53 and 68º, respectively. Gap fractions are given for the breast-height level (1.3m) LAI-2000 measurements (labelled as B, columns from Z to AD) and ground-level (G, columns from AH to AL). The gap fraction for the understorey vegetation (columns from AO to AS), only, are calculated as the ratio of mean values of gap fraction at the ground level and breast-height level (G/B). In column AE, the inverted values of the canopy LAI by using Nilson's method are given. In column AF, the canopy LAI values as determined from the data containing in the forestry database are given. In column AT the inverted LAI value of the ground vegetation obtained from the gap fraction data in columns AO-AS by the standard method of LAI-2000 are given. LAI_total (column AV) is the sum of LAI_canopy and LAI_ground-veget both estimated by the inversion method.

LAI-2000 data processing was made with the same methods as described in 2000.

For Nilson's algorithm, see also the report of 2000. The only difference in the algorithm from that of in 2000 was that crown and canopy closures were not measured in 2001. Canopy closure estimates were derived from the average for the whole plot LAI-2000-estimated gap fraction in the highest ring (7º).

Comments on the inverted data in the file summary_data.xls

Forestry database for the region was created in 1994/1995. By now the information containing in the database is, to some extent, out of date mainly beacuse of management treatments made in the forests – clear cutting and thinning. Also in some very young stands, during the time interval 5-6 years substantial changes may occur. Although we avoided ignoring very drastic changes, like clear cutting, nevertheless in many cases the forestry data used in calculating the initial guess of the canopy LAI did not correspond to the present situation. This is the main reason why in several cases there are considerable differences between the LAI estimates obtained by the two methods.