A STUDY AREA FOR VALIDATION OF LSA SAF PRODUCTS

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ABSTRACT

Validation of land biophysical products (albedo, LAI, FVC) derived from large swatch sensors (AVHRR, POLDER, MERIS, VEGETATION) is one of the current issues of the remote sensing community. LSA SAF project (WWW1) is focused on the exploitation of the forthcoming EUMETSAT MSG and EPS satellites for land surface applications. Validation is necessary to assess the accuracy of LSA SAF derived products. This is a very hard task when using coarse spatial resolution data due to ground-based measurements are rather difficult to compare with sensor data. Therefore, development of appropriate ground-based validation techniques is critical to assessing the uncertainties associated with such data products (Lucht et al., 2000). A particular emphasis must be given to the MSG and EPS systems due to the different viewing and illumination angles involved and the associated BRDF algorithms for the retrieved products.

The objective of this paper aims to present a study area which has been selected in order to validate the LSA SAF product level 3 (biophysical variables) products. The study area has been selected into Castilla-La Mancha region (central of Spain) according to many previous Remote Sensing experiments.

The area involves two different sub-areas, each one addressing one specific validation approach. A small area was considered for ground measurements campaigns. Nevertheless, comparisons are generally difficult since *in-situ* observations and the generated products usually result from different processes and are of a different nature. Hence a larger area was also selected to take into account the upscaling between local measurements and space-derived products.

1. INTRODUCTION

Different international efforts are being conducted in order to establish standard methods and protocols for high-level products validation. Common field sites and methods for data collection and presenting product accuracy can be expected to foster product standardization and sensor's

synergy (Justice et al., 2000). International approaches include the IGBP 1 km Global Land Cover 'Validation' (Belward et al. 1999, WWW 2), the EOS MODIS 'Validation' (WWW 3), which includes MODIS LAI/FAPAR validation protocol designed by the BigFoot program (Thomlinson et al. 1999, WWW 4), or the Validation of Land European Remote sensing Instruments (VALERI) European Network (WWW 5) among others (Justice et al., 2000).

In order to validate the LSA SAF level 3 (biophysical variables) products, a study area has been selected in the Castilla-La Mancha region (central Spain) according to many previous Remote Sensing experiments. The next section describes the general characteristics of the study area. The test sites are presented in section 3. Finally, a brief introduction to the ancillary data is shown in section 4.

2. VALIDATION AREA DESCRIPTION

The validation area involves three provinces of the Castilla-La Mancha region: Albacete, Cuenca and Ciudad Real. It is delimitated by the following UTM coordinates X (m): 493000, 630000 and Y (m): 4280000, 4380000 and covers 13700 km^2. This area was originally selected due to its flat morphology, thus minimising the complication introduced by topography, and the presence of large, uniform man-made vegetated units, suitable for validation of remote sensing instruments and derived products. The area was employed as a test site for the EFEDA (European International Project on Climatic and Hydrological Interaction between Vegetation, Atmosphere and Land Surface, Field Experiment in Desertification Threatened Areas) experiment in 1991 (Bolle et al., 1993).

The climate is of Mediterranean type, with heaviest rainfalls in spring and autumn and lowest in summer; it presents a high grade of continentality, with quite sudden changes from cold months to warm months and high thermic oscillations in all season between the maximum and minimum daily temperatures. The rainfall statistics from 1931-1960 (Mata, 1984) show that the mean annual rainfall is little more than 400 mm in most of the study area, making La Mancha one of the driest regions in Europe. Precipitation is seasonal, with a minimum in summer (June-August) and a high year-to-year variability. Figure 1 shows the location of the study area in Castilla-La Mancha and Spain over AVHRR/NOAA image.

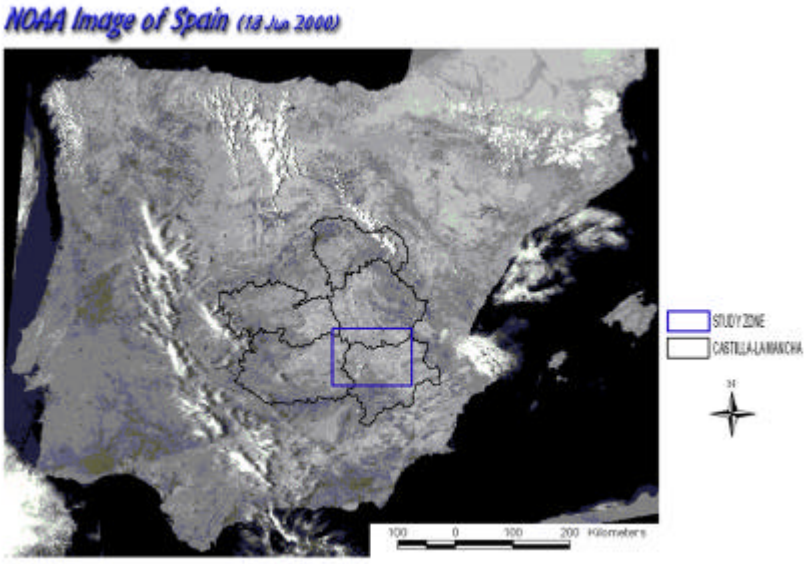

Figure 1. Location of the study area in Castilla-La Mancha and Spain over AVHRR/NOAA image.

Until recent decades La Mancha was predominantly a dryland farming area. However, exploitation of groundwater resources for irrigation has increased largely and some 20% of the area of the main aquifers system, which cuts through the area from north to south, is nowadays subjected to intensive, irrigated agriculture. The resultant long-term depletion in groundwater levels highlights the criticality of water resources in much of the study area (Bolle et al., 1993).

The area involves two different focal areas. Barrax is a small area considered for ground measurements campaigns which includes concomitant field and tower measurements, fine-resolution and medium-resolution imagery from airborne and satellite sensors. Nevertheless, comparisons are generally difficult since in-situ observations and the generated products usually result from different processes. Hence a larger area has been selected to take into account the upscaling between local measurements and space-derived products. For this purpose, the Villarobledo-Tomelloso vineyard area was selected to take advantage of the high-resolution sensor airborne data available and cadastral data in a region which experiment frequent changes. Figure 2 shows the location of the two focal areas.

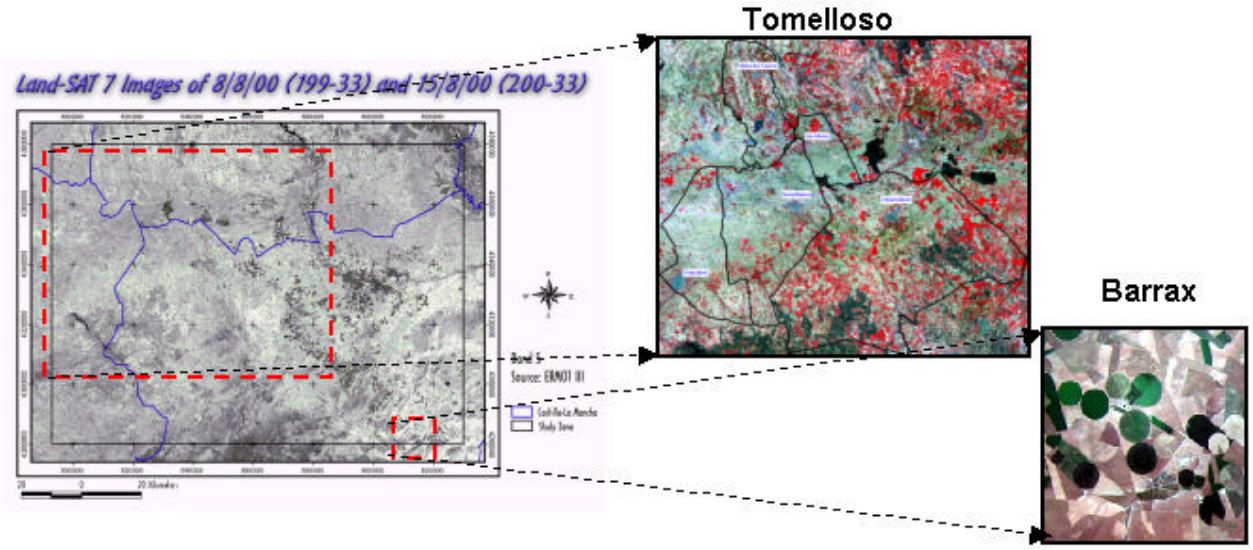

Figure 2. Mosaic of two Landsat-7 images corresponding to 199-33 and 200-33 images with the two focal areas: Tomelloso and Barrax. The Tomelloso image belongs to a RGB composition (ETM4, ETM3, ETM2) obtained by the satellite Landsat-7 on 25 April 2000. The Barrax image shows a RGB POLDER composition (5, 3, 1).

3. FOCAL AREAS

3.1 Barrax test site

Activities in Barrax were extended as part of the EFEDA-II project (1993-1995), and continued through the RESRAPS (Remote Sensing and Radiometric Properties of the Surface) EU Project. Additional activities were performed around the RESMEDES (REmote Sensing of the MEditerranean Desertification and Environmental ChangeS) EU Project during 1996. In 1997, an additional field campaign was carried out under the framework EU/STAAARTE (Scientific Training and Access to Aircraft for Atmospheric Research Throughout Europe) program among others international initiatives in this area. This area was also selected by ESA as a test site for the preparation activities for the Land Surface Processes and Interactions Mission (LSPIM) Earth

Explorer candidate Core Mission (ESA, 1999). As part of these activities, the DAISEX (Digital AIrborne Spectrometer EXperiment) campaigns were carried out during 1998, 1999 and 2000 (Moreno et al., 2001). During DAISEX campaigns, many different airborne data were collected including hyperspectral (HYMAP, DAIS, ROSIS) and multiangular POLDER data. All the information about DAISEX and the pre-processed data are available in the DAISEX homepage (WWW6). In addition, ancillary information of this test site is being developed in the framework of the Scientific Analysis of the ESA Airborne Multi-Annual Imaging Spectrometer Campaign DAISEX Project.

The Barrax site is situated in the west of the province of Albacete, 28 km from the capital town (39º 3' N, 2º 6' W). The landscape in this area is flat with no change of elevation higher than 2 m over the whole area. Under the Barrax area several aquifers geological formations exist. These formations (Holocene, Miocene, Cretaceous and Jurassic) seem to be connected and form a regional groundwater body. The regional water table is about 20-30 m below land surface. Nevertheless, there is some evidence that, at least locally, several perched aquifers exist with their water table between 4 and 7 m deep.

The soils of the area have been poorly developed. They are very finely textured and have a high degree of compactness under drying conditions. All soils show a calcic hard-pan layer at approximately >40 cm below the surface. The main limitation offered by the soils regarding their productive capacity is the small real depth, due to the presence of the petrocalcic horizon with large amounts of total and/or active limestone. The stoniness is excessive in many cases due to the presence of remains of the petrocalcic horizon on the surface.

The Barrax test site area is 5x5 km^2. The study zone is defined by the following UTM coordinates X (m): 576000, 581000 and Y (m): 4321000, 4326000 (see figure 3). This area is suitable for ground-based measurements because it involves the experimental farm 'Las Tiesas' belonging to the "Escuela Técnica Superior de Ingenieros Agronomos" of the University of Castilla-La Mancha.

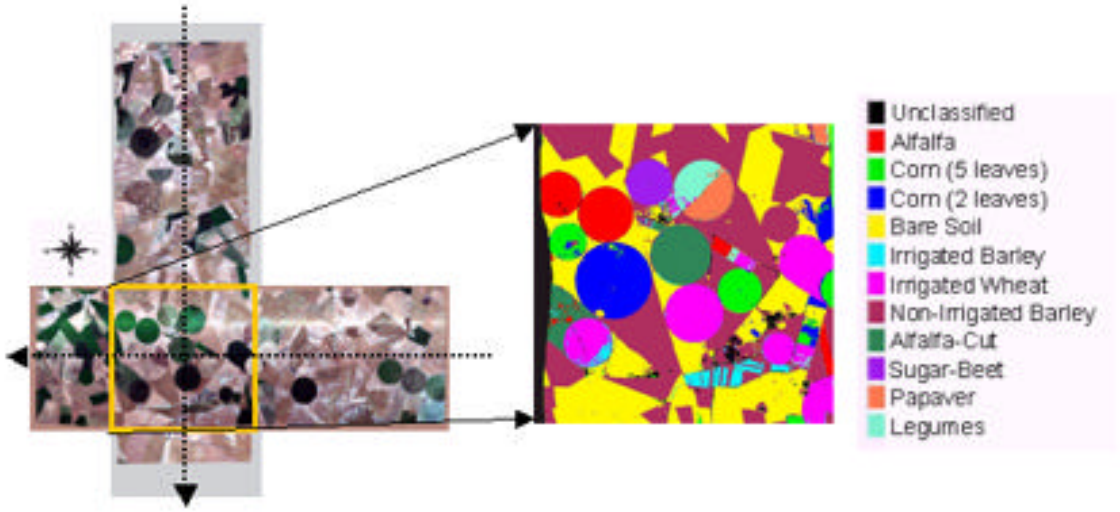

Figure 3. RGB (5, 3, 1) POLDER composition of the Barrax study are the two images have been acquired with different observation conditions. A Land Use Classification is also presented.

The dominant cultivation in the area is approximately 65% dry land (of which 67% are winter cereals and 33% fallow land) and 35% irrigated land (corn 75%; barley/sunflower 15%; alfalfa 5%; onions 2.9%; vegetables 2.1%) with several extensive irrigated circular man-made agricultural crops up to 1km of diameter. The senescent biomass and vigorous vegetation are distributed in different proportions according to date and crop phenology. An example corresponding to 6 June 1999 is presented in figure 4.

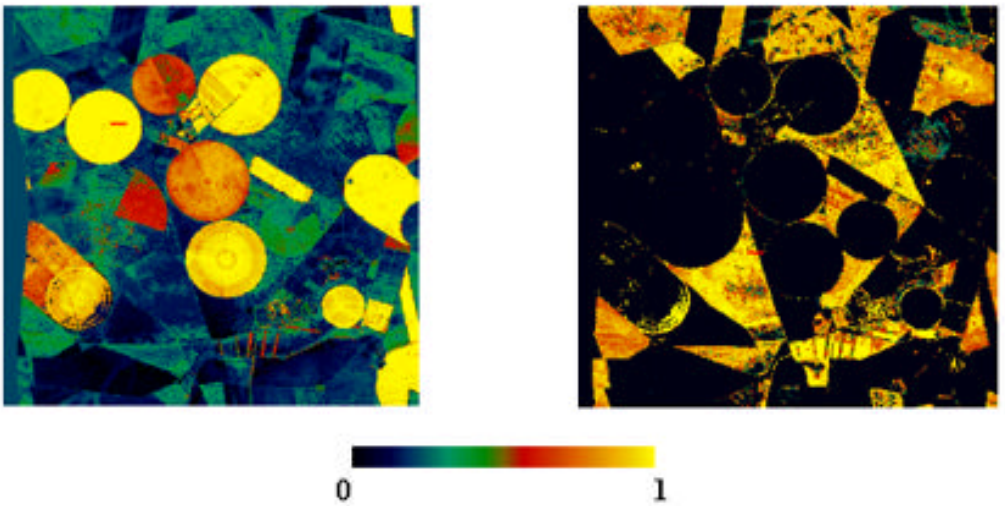

Figure 4. Fraction of green and died vegetation coverage.

The University of Castilla-La Mancha operates three agro-meteorological stations through the study area:

a) Las Tiesas-Anchor Station (39º 02' 31'' N; 2º 04' 55'' W)
b) Las Tiesas-Lysimeter Station (39º 03' 30'' N; 2º 05' 24'' W)
c) Blancares Station (39º 06' 45'' N; 2º 06' 40'' W)

These stations belong to the Permanent Station Network of the University of Castilla-La Mancha and are connected by modem with the central computer at the Institute for Regional Development (IDR) in Albacete. The data are compiled and stored automatically for later treatment, although they are also accessible in real time.

3.2 Tomelloso Area

Vegetation change detection is a powerful application of remote sensing, in that the spectral, temporal and directional resolution of multi-sensor approaches can be used to advantage in monitoring both significant and subtle land cover changes over time at global scale (Munyati, 2000). The importance of mapping, quantifying, and monitoring the changes in physical characteristics of land cover has been widely recognized by the scientific community as a key element in the study of global change (IGBP 1990, Henderson-Sellers and Pitman 1992). Validation of land use change products derived from large swatch sensors is necessary to assess the change maps accuracy.

The study zone is defined by the following UTM coordinates X (m): 495096, 557110 and Y (m): 4321694, 4379098 (see figure 5) and involves several councils (Villarobledo, Tomelloso, and Mota del Cuervo, among others). The area is cultivated by the vineyard crop in a proportion of about 50%. There are other cover types that alternate with the vineyard, such as dry crops, irrigated crops, olives, fallow and forest. The landscape area presents different types of soils: brown soils and calcic brown soils dedicated especially for cereals and forest respectively, and calcic soils. The vineyard is well adapted to calcic soil (i.e. dry, little developed soils), which allows the crop to maintain excellent green vegetation throughout the summer period.

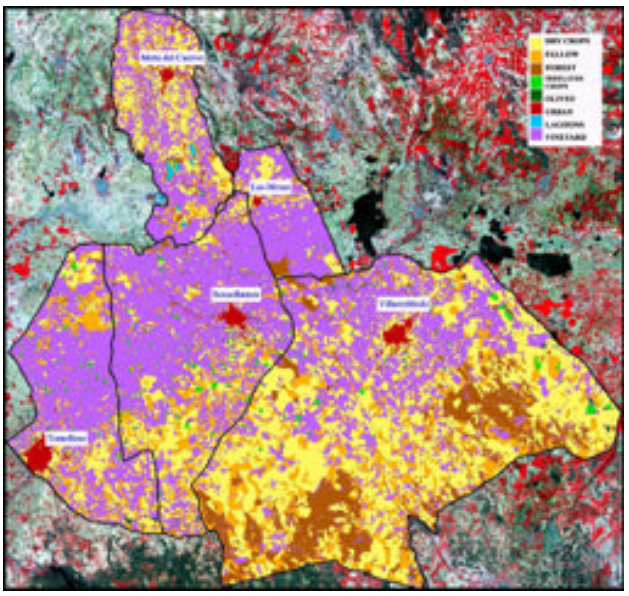

Figure 5. Land use map of the Tomelloso area corresponding to 2000 as obtained using the multitemporal masking classification method (Lanjeri et al. 2001). An ETM+/Landsat 7 RGB composition (4,3,2) of the study area, taken on 25 April 2000, is underimposed.

The vineyard has been considered as a good indicator of the desertification process in the EFEDA, RESMEDES/RESYSMED projects and also in the project "Evaluación por Teledetección de la incidencia de los cambios de la cubierta vegetal del suelo en los flujos de agua y energia" funded by the CYCIT. Castilla-La Mancha is an especially rapidly changing region regarding the vineyard (see figure 6). In 1983, this crop covered 752.081 ha, being one of the highest vineyard concentrations in the world, while it covered 620.609 ha in 1993 (JCCLM 1998).

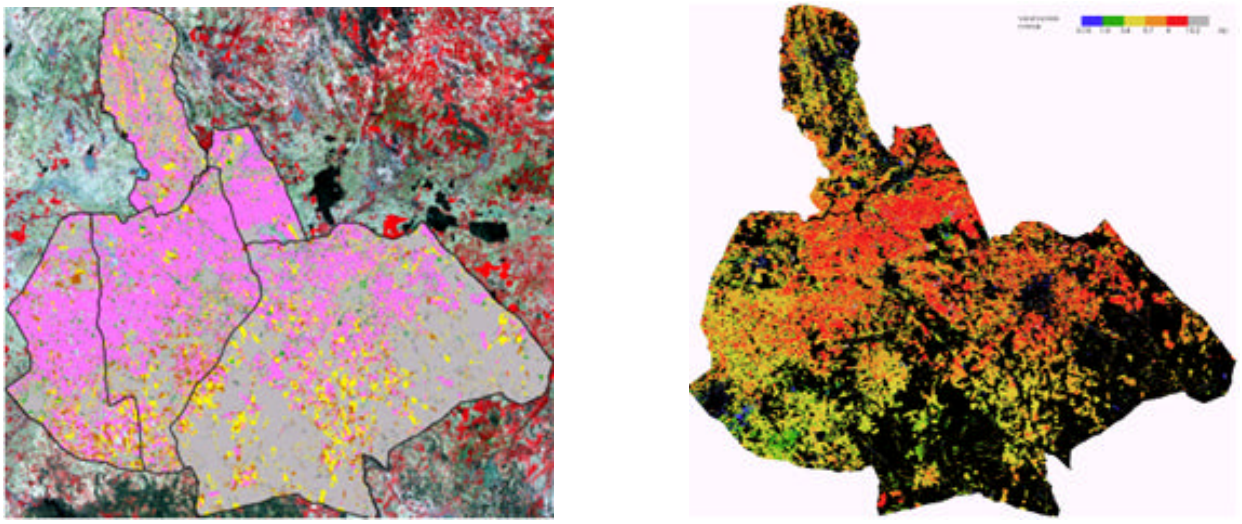

Figure 6. Vineyard change map for 1991-2000 period obtained using the Change Vector Analysis (CVA) method. Vineyard surface cover map for 1991 obtained using Landsat TM imagery.

4. ANCILLARY DATA

A summary list of the available ancillary data is shown below:

1.Cartographic maps, including contour lines, administrative divisions, roads, railways and drainage network.

2. Different hidrological maps, including the river/channels and the ephemeral strings as well as the aquifers.
3.Digital elevation models, e.g. USGS Global DEM-GTOPO30, WGS84 coordinate system, with a resolution of 30 arc seconds (approximately 1 km).

4.Forestal maps, (1:50,000) which reveals that the validation area consists mainly of agricultural land, although the presence of quercus ilex and pinus halepensis is also significant.

5.Land use map, (1:50,000) which shows the dominance of fallow land followed by vineyard and sowed land.
6.Climatic data, historical data bases of climatic registers measured from termo-pluviometric stations and weather stations are accessible from INM and IDR.

7.Corine land cover data base.

All the information presented in this paper can be found in a CD Rom, which is currently being developed in the context of the LSA SAF Consortium. The CD collects also maps and detailed information of the validation and focal areas that has not been presented here as well as a series of maps and examples of climatic data sets belonging to the ancillary data exposed above.

ACKNOWLEDGMENTS

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BIBLIOGRAPHIC REFERENCES

BELWARD, A. S., ESTES, J. E., and KLINE, K. D., (1999). The IGBP-DIS global 1-km land cover data set DISCover: a project overview. *Photogrammetric Engineering and Remote Sensin*g, 65, 1013–1020.

BOLLE, H.J., et al, (1993). EFEDA: European field experiment in a desertification-threatened area. *Annales Geophysical*, 173-189.

MUNYATI, C., (2000). Wetland change detection on the Kafue Flats, Zambia, by classification of multitemporal remote sensing image dataset. *International Journal of Remote Sensing*, 21, 1787-1806.

IGBP (International Geosphere Biosphere Programme), (1990). The international Geosphere Biosphere Programme: A study of global change, The Initial Core Projects Report No. 12. International council of Scientific Unions, Stockholm, Sweden.

HENDERSON-SELLERS, A., and PITMAN, A. J., (1992). Land-surface schemes for future climate models: specification, aggregation, and heterogeneity. *J. Geophys. Res*., 97**,** 2687-2696.

LANJERI, S., MELIA, J., and, SEGARRA, D., (2001). A multi-temporal masking classification method for vineyard monitoring in central Spain. *International Journal of Remote Sensing,* 22, 3167-3186.

JCCLM, (1998). Datos de superficie de vid en secano en Castilla-La Mancha. Junta de Comunidades de Castilla-La Mancha (internal report).

JUSTICE, C. O., BELWARD, A., MORISETTE, J., LEWIS, P., PRIVETTE, J., and BARET, F. (2000), Developments in the 'validation' of satellite sensor products for the study of the land surface. *Int. J. Remote Sens*. 21(17):3,383-3,390.

MATA, C. A., (1984). Fichas hídricas normalizadas y otros parámetros hidrometeorológicos. Instituto Nacional de Meteorología, Madrid.

MORENO, J., CALERA, A., CASELLES, V., CISNEROSN, J.M., MARTINEZ-LOZANO, J.A., MELIÁ, J. MONTERO, F. and SOBRINO, J. (2001). The measurements programme at Barrax. ESA-DAISEX proceedings, ESA SP-499, 43-52.

THOMLINSON, J. R., BOLSTAD, P., and COHEN, W., (1999). Coordinating methodologies for scaling land cover classification from site specific to global; steps towards validating globally based map products. *Remote Sensing of Environment, 70, 16-28.*

WWW 1, LSA SAF homepage: : http://www.meteo.pt/landsaf/

WWW 2, IGBP DISCover 'Validation' Working Group: http://keystone.geog.ucsb.edu/igbp.html

WWW 3, EOS 'Validation' Investigations: http://eospso.gsfc.nasa.gov/validation/frame.html

WWW 4, BigFoot program: http://www.fsl.orst.edu/larse/bigfoot/

WWW 5, VALERI homepage: http://www.avignon.inra.fr/valeri/