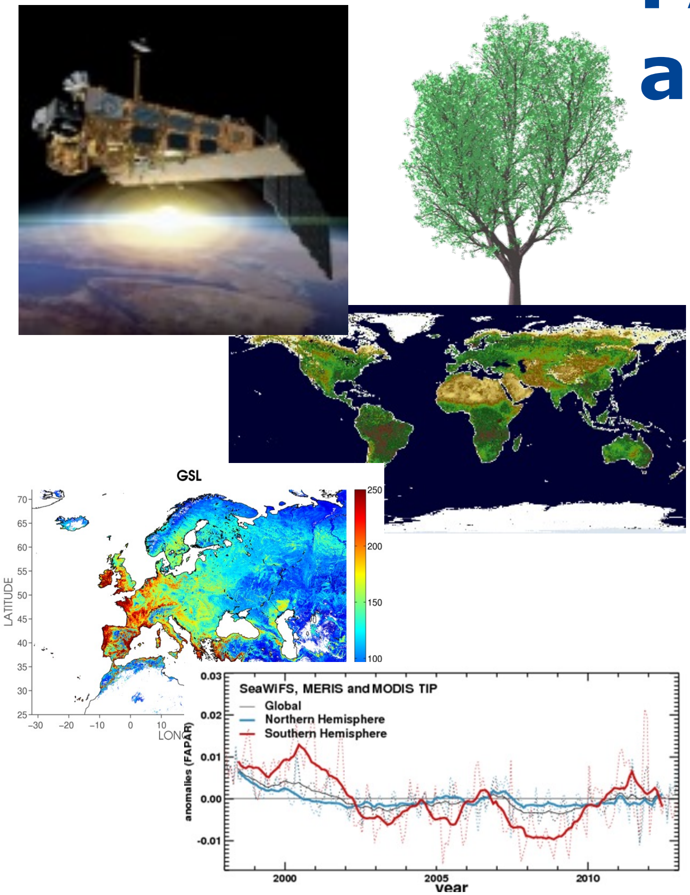
CEOS Working Group on Calibration and Validation

European Commission

LPV Mission

To foster quantitative validation of higher-level global land products derived from remote sensing data and to relay results so they are relevant to users

FAPAR inter-comparison and validation status



Nadine Gobron[1] and Arturo Sanchez-Azofeifa[2]

(1) EC-JRC / Institute for Environment and Sustainability, Ispra, Italy
(2) Centre for Earth Observation Science (CEOS), University of Alberta , Edmonton, Alberta, Canada

GCOS requirements

European Commission

Horizontal Resolution	Vertical Resolution	Temporal resolution	Accuracy	Stability
250 m	n/a	2-weekly averages (based on daily sampling)	Max(10%;0.05)	Max(3%;0.02)

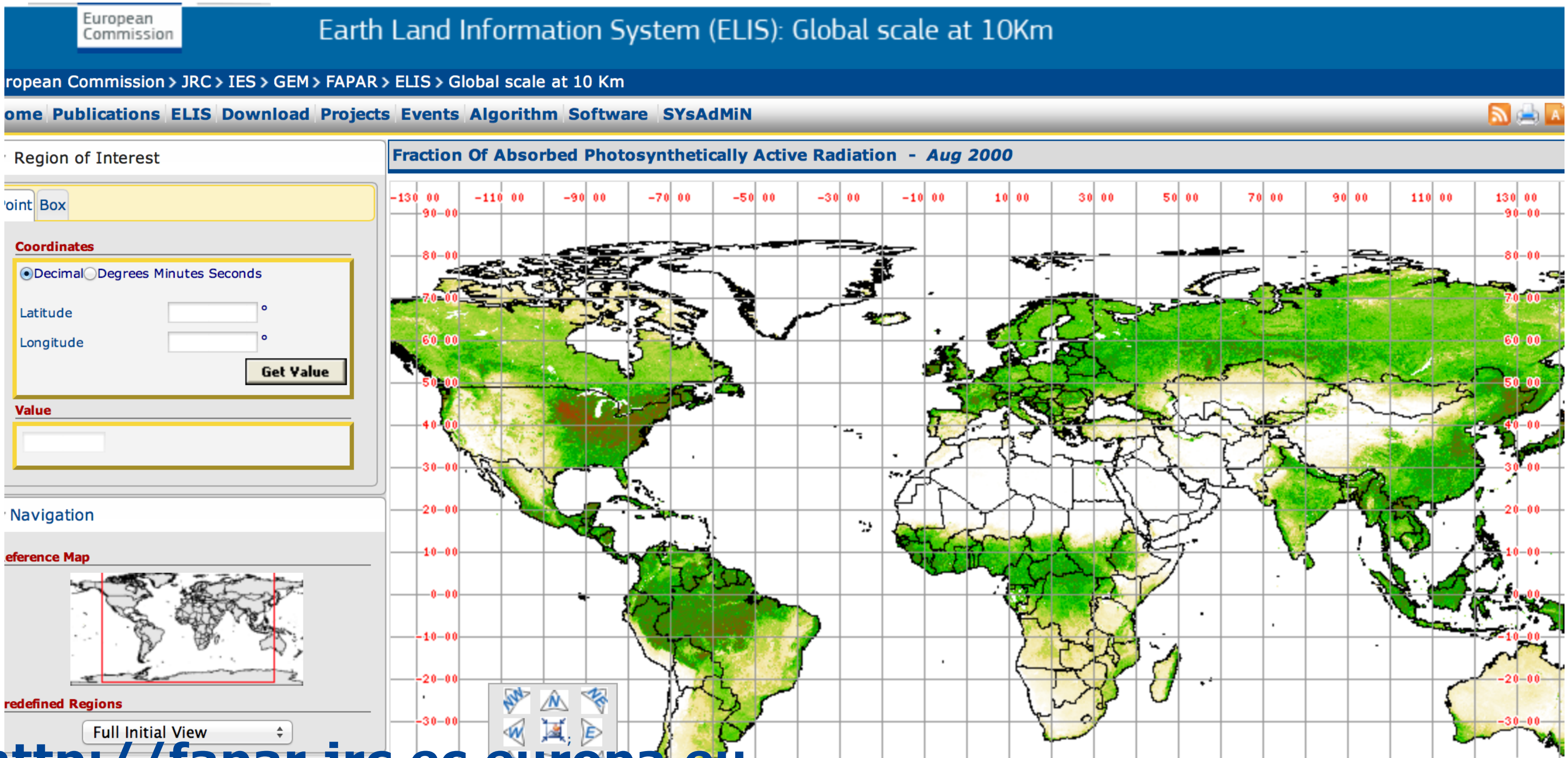
“Both black-sky (assuming only direct radiation) and white-sky (assuming that all the incoming radiation is in the form of isotropic diffuse radiation) FAPAR values **may be considered**. Models describing the primary productivity of plants and the energy balance of the land surface require either a characterization of the **diurnal evolution of FAPAR or the daily integrated value of FAPAR, depending on the time step used**. Other applications may only **require cumulative or aggregated values over longer periods**.” (GCOS 154)

Overview of space products

Projects/Institution Sensors/Period	Temporal Coverage/Output product definition	Spatial Coverage	References
JRC-FAPAR SeaWiFS ESA MERIS (07/97-04/12)	Daily/10-days/monthly Instantaneous green FAPAR based on direct incoming radiation	~ 1 km	Gobron et al (2000,2006, 2008)
NASA MODIS LAI/FPAR (00-on going)	8-days FAPAR with direct and diffuse incoming radiation	~ 1 km	Knyazikhin et al. (1998b)
NASA MISR LAI/FPAR (00-on going)	8-days FAPAR with direct and diffuse incoming radiation.	~ 1 km	Knyazikhin et al (1998a)
CYCLOPES VEGETATION 1999-2007	Black Sky green FAPAR at 10:00 solar local time	~ 1 km	Baret et al (2007)
JRC-TIP MODIS/MISR (00-On going)	8-(16) days Standard FAPAR or/& Green FAPAR for direct or/& diffuse incoming radiation	~ 1 km	Pinty et al. (2007)
GEOV1 VEGETATION (99-2012)	10-days FAPAR at 10:00 solar local time (but based on monthly BRF correction)	~ 1 km	Baret et al (2007)
LandSAF MSG (2006-on going)	Daily/10-days Instantaneous green FAPAR based on direct incoming radiation	~ 3 km	

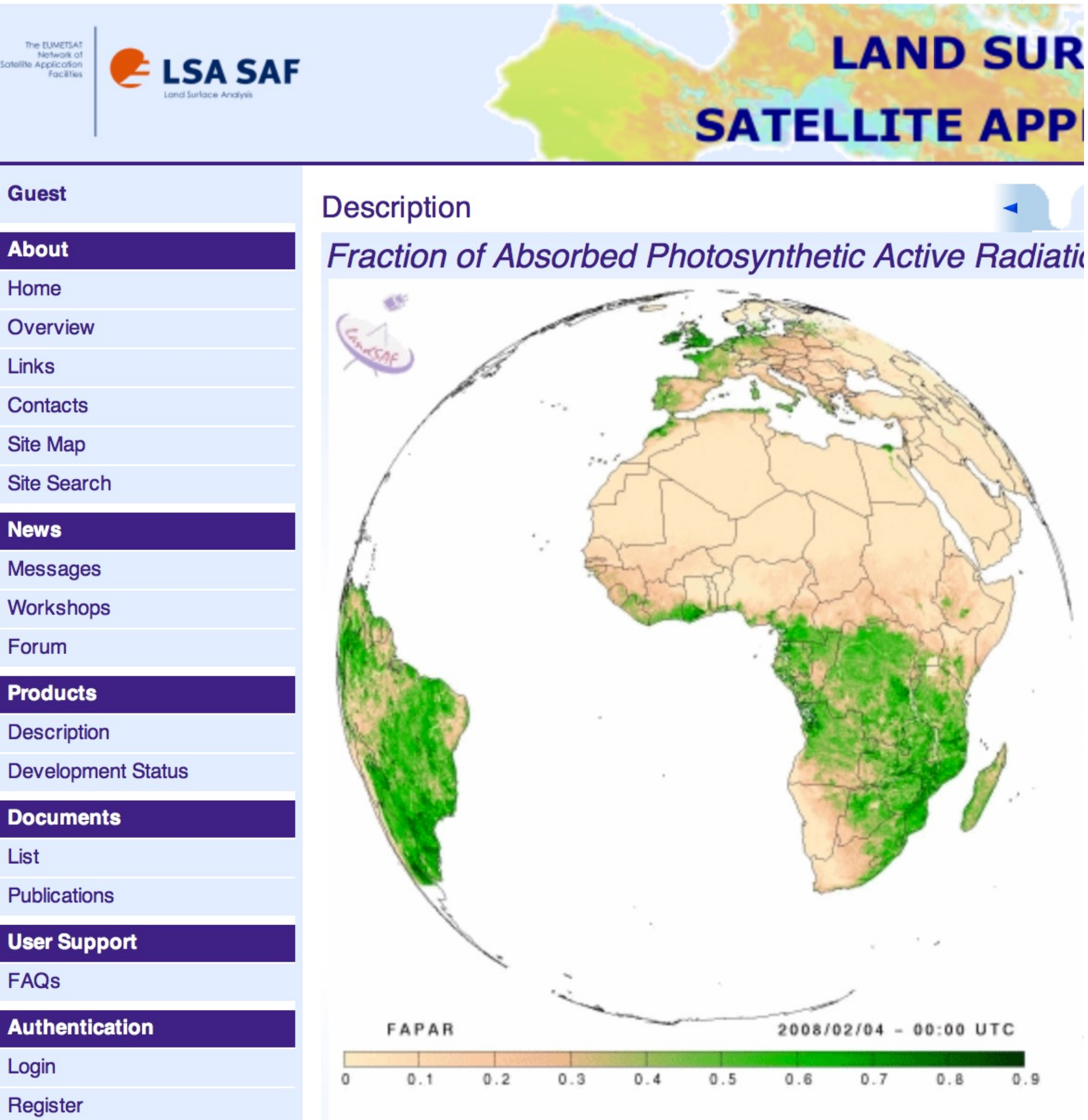
JRC-SeaWiFS

The design of the JRC **FAPAR** algorithm is based on a two steps procedure where the spectral radiances measured in the red and near-infrared bands are, first, rectified in order to ensure their decontamination from atmospheric and angular effects and, second, combined together in a mathematical formulae to generate the **FAPAR** value. The top of atmosphere (**TOA**) channel values are first normalized by the anisotropy function to take into account the angular effects



http://fapar.jrc.ec.europa.eu

LandSAF



http://landsaf.meteo.pt

A statistical approach is proposed for retrieving daily FAPAR from BRDF data, corrected of surface's reflectance anisotropy and minimising the effect of soil reflectance (Roujean and Bréon, 1995). The principle of the algorithm is based on simulations of visible and near infrared spectral reflectance values in optimal angular geometries identified based on numerical experiments (simulations of a radiative transfer code). A vegetation index, called RDVI (Renormlized Difference Vegetation Index), is introduced, which shows to be less sensitive to background reflectance variability. A pre-established relationship is then applied between RDVI computed in an optimal angular geometry and daily FAPAR.

Overview of space products accuracy

Projects/Institution Sensors/Period	Temporal Coverage/Output product definition	Uncertainties	Accuracy against ground-based	References
JRC-FAPAR SeaWiFS ESA MERIS (07/97-04/12)	Daily/10-days/monthly Instantaneous green FAPAR based on direct incoming radiation	**+/- 0.05 (theory) + f (band calibration) (3-4 %)**	**Depend on RT regime (i.e land cover) ±0.1 compared to FIPAR (EOS sites, Dahra)**	Gobron et al (2000, 2006, 2008)
NASA MODIS LAI/FPAR (00-on going)	8-days FAPAR with direct and diffuse incoming radiation	**Standard deviation from RT retrieval**	**from 0.2 to 0.05-0.4 Depend on land cover type.**	Fensholt et al. (2004) Huemmrich et al. (2005) Steinberg, et al. (2006)
NASA MISR LAI/FPAR (00-on going)	8-days FAPAR with direct and diffuse incoming radiation.	**Standard deviation from RT retrieval**	n/a	n/a
CYCLOPES VEGETATION 1999-2007	Black Sky green FAPAR at 10:00 solar local time	n/a	**RMSE=0.1 compared to FIPAR (OLIVE DIRECT Sites)**	Baret et al (2007) Weiss et al (2007)
JRC-TIP MODIS/MISR (00-On going)	8-(16) days Standard FAPAR or/& Green FAPAR for direct or/& diffuse incoming radiation	**PDF**	**±0.1 compared to FIPAR (EOS sites, Dahra and Hainich site)**	Pinty et al. (2007)
Copernicus Global Land VEGETATION (99-2014) GEOV1	10-days FAPAR at 10:00 solar local time (but based on monthly BRF correction)	n/a	**RMSE=0.08 Bias= 0.014 Compared to FIPAR (CEOS OLIVE DIRECT sites). No samples=42**	Baret et al (2013) Camacho et al. (2013)
LandSAF MSG (2006-on going)	Daily/10-days integrated green FAPAR based on direct incoming radiation	**Depend on the input (BRDF). Typically better than 0.1.**	**±0.11 compared to FIPAR (VALERI sites) (not peer-reviewed)**	García-Haro et al (2013a) García-Haro et al (2013b) Martínez et al (2013)

References (to be updated …)

- *García-Haro, F.J., Camacho, F., Meliá, J., 2013. Algorithm Theoretical Basis Document for Vegetation parameters (VEGA), SAF/LAND/UV/ATBD_VEGA/2.1, December 2013, 34 pp.*
- *García-Haro, F.J., Camacho, F., Martínez, B., Meliá, J., 2013. Validation Report Vegetation Parameters (VEGA), SAF/LAND/UV/VR_VEGA/2.1-4, December 2013, 34 pp.*
- Martínez, B., Camacho, F., Verger, A., García-Haro, F.J., Gilabert, M.A. 2013. Intercomparison and quality assessment of MERIS, MODIS and SEVIRI FAPAR products over the Iberian Peninsula. International Journal of Applied Earth Observation and Geoinformation, 21, 463–476.
- Baret, F., Weiss, M., Lacaze, R., Camacho, F., Makmara, H., Pacholczyk, P., et al.(2013) GeoV1: LAI, FAPAR Essential Climate Variables and FCOVER global time series capitalizing over existing products. Part 1: Principles of development and production. Remote Sensing of Environment, 137, 299–309.
- Camacho, F., J. Cernicharo, R. Lacaze, F. Baret, M. Weiss (2013) GEOV1: LAI, FAPAR essential climate variables and FCOVER global time series capitalizing over existing products. Part 2: Validation and Intercomparison with reference products. Remote Sensing of Environment 137 (2013) 310–329

GCOS statements (2)

European Commission

“To ensure the continuity of the FAPAR product across multiple sensors and platforms, a minimum overlap of one year (a full seasonal cycle) should be arranged between successive missions to allow for the inter-comparison and inter-calibration of sensors and the eventual adjustment of retrieval algorithms.”

Products	JRC SeaWiFS	ESA MERIS	NASA MODIS	CYCLOPES VGT	JRC-TIP MODIS	GEOV1 VGT	SAF MSG
JRC SeaWiFS		**Global** 0.5 deg. 2002-2006 Gobron et. al, 2010 **Europe** 1km 2002-2006 Horn of Africa 2002-2006 Ceccherini et al., 2013 **Australia** 2002-2006 *Pickett-Heaps C. A., 2014*	**Australia** 2002-2006 *Pickett-Heaps C. A., 2014*	**Northern Eurasia**, 2000 *McCallum et al 2010*	**Global** 2005 **Australia** 2002-2006 *Pickett-Heaps C. A., 2014*	**Australia** 2002-2006 *Pickett-Heaps C. A., 2014*	
ESA MERIS			**Spain** 2003 Seixas et al, 2009 **Europe** 1km 2011 D'Odorico P. et al., 2014 **Australia** 2002-2011 *Pickett-Heaps C. A., 2014*	**Australia** 2002-2011 Pickett-Heaps C. A., 2014	**Australia** 2002-2011 Pickett-Heaps C. A., 2014 **Europe** 1km 2011 *D'Odorico P. et al., 2014* **Global** 2002-2012 *Gobron et. al., 2013*	**Australia** 2002-2011 *Pickett-Heaps C. A., 2014*	**South-Africa, Europe** 2006-2007 **Iberian Peninsula** 2006-2007
NASA MODIS				**Northern Eurasia** 2000 McCallum et al 2010 **Belmanip**, 2000-2003 Weiss et al, 2007 **Australia** 2002-2009 *Pickett-Heaps C. A., 2014*	**Australia** 2002-2011 Pickett-Heaps C. A., 2014 **Europe** 1km 2011 *D'Odorico P. et al., 2014*	**Australia** 2002-2011 *Pickett-Heaps C. A., 2014*	**Belmanip** 2007-2010 **Africa** 2007-2010 **Iberian Peninsula** 2006-2007
CYCLOPES VGT					**Australia** 2002-2009 *Pickett-Heaps C. A., 2014*	**Australia** 2002-2009 *Pickett-Heaps C. A., 2014*	
JRC-TIP MODIS (MISR)						**Australia** 2002-2011 *Pickett-Heaps C. A., 2014*	
GEOV1 VGT							
LSAF MSG							

Workshop Outputs

European Commission

- Do we want to compare against other source of data ?
- Do we want to go to an ensemble climatology approach ?
- Best metrics for inter-comparison (with priorities) for:

1. Global (sub-sampling as Belmanip & Level 3 products)
2. Regional (which regions?)
3. Local (define matchup criteria)
4. Temporal scale

R^2, temporal biais, RMSD (&) Unsystematic & Systematic) ?
Agreement Coefficient (AC) ?
Smoothness ? Time series noise analysis
From Aerosols community: Accuracy (A) = the biais ; Precicion (P)= the repeatability ; Uncertaintities (U) etc …

Qualitative analysis is needed: CEOS LPV message to data providers

Categorization Metric Table

	Global Level 3 products? And level 2 Belmanip sites (ensuring homogeneity)	Regional (define golden regions?)	Local ??	Priority
RMSE	< 5% ?	<		high?low?
Seasonal correlation	> 0.8?	>??	> ??	
TCEM	Belmanip Sites ?			
Others ??				

- **Main problems of referenced work and future validation**

Direct comparisons have been made over few sites in term of seasonality (Dahra, BigFoot ones)

Old collection for MODIS

Indeed direct contains one date for each site

It will take times to make future validation in a harmonized way … and educate people.

- **CEOS LPV validation stage of product (your view)**

Stage 1 ;-(-

- **Status of promised GCOS action item contributions (if any)**