



Global Land Service

Challenges for monitoring
the continental ecosystems
in the Copernicus Global
Land Service, from
SPOT/VGT to Sentinels

Roselyne Lacaze (HYGEOS)
on behalf the consortium

“Production of Vegetation & Energy products”
led by VITO

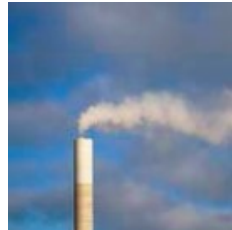
Copernicus context



Land



Marine



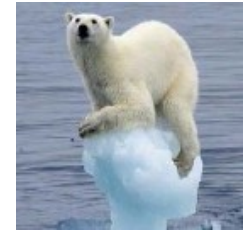
Atmosphere



Emergency



Security



Climate Change

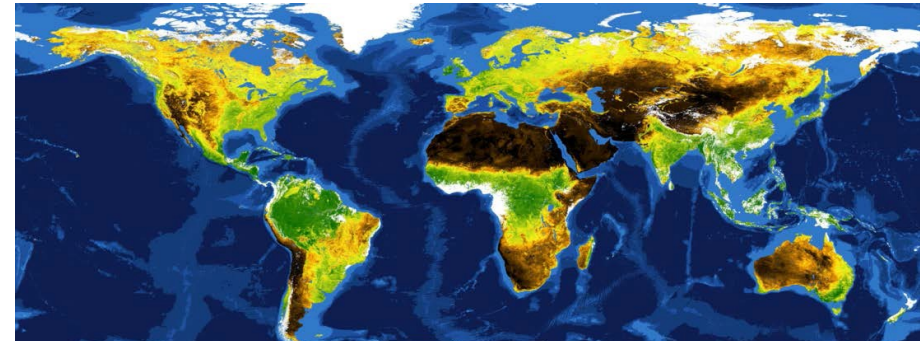
In-Situ Component



Local Component



Pan-European Component



JRC

EUROPEAN COMMISSION

Global Component

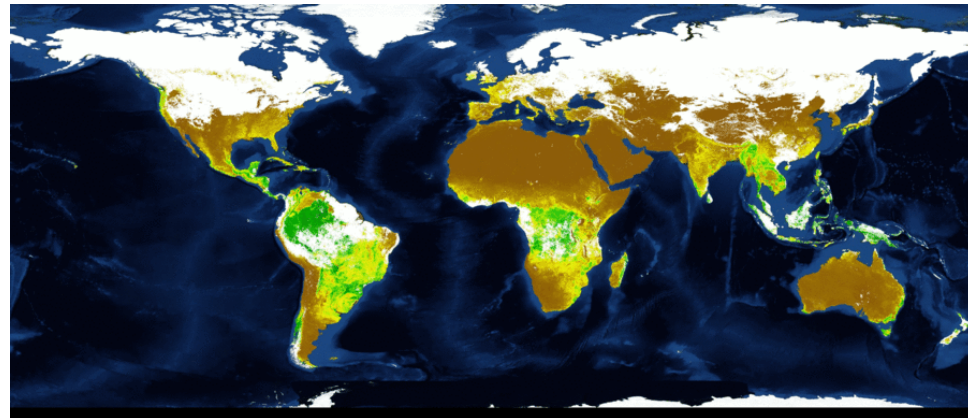
Global Component of the Land Service *Concept*

Heritage 2004-2014:

- EU R&D activities (Geoland-1&2, VGT4Africa, DevCoCast, ...)
- DG (DEVCO, ENV, ECHO, AGRI), MS, ESA, Eumetsat activities
- GMES Initial Operations 2012-2014
- Copernicus Regulation (EU) 377/2014 (03/04/2014)

The Global Land Service provides:

- Timely production in near-real time
- Off-line re-processing, delivering consistent time series
- Long Term Data Preservation
- Highly qualified products
- Reliability & sustainability
- Free and open data access



Global Component of the Land Service Objectives

Support EU Policies in the following areas:

- Agriculture & food security
- Land degradation & desertification
- Forest & water resources management
- Biodiversity
- Rural development
- Climate change



Global Component of the Land Service Portfolio

| Variable | Temporal coverage | Temporal resolution | Spatial coverage | Spatial resolution | Sensor | Timeliness |
|--------------------------|-----------------------------------|---------------------|------------------|--------------------|----------------------------|------------|
| LAI/FAPAR/FCover | 1999 - present 2014 - present | 10 days | Global | 1 km 300 m** | SPOT/VGT PROBA-V | 3 days |
| NDVI/VCI/VPI | 1999 - present 2014 - present | 10 days | Global | 1 km 300 m | SPOT/VGT PROBA-V | 3 days |
| Dry Matter Productivity | 1999* - present 2014 - present | 10 days | Global | 1 km 300 m* | SPOT/VGT PROBA-V | 3 days |
| Burnt Areas | 1999 - present 2014 - present | 1 day | Global | 1 km 300 m | SPOT/VGT PROBA-V | 3 days |
| TOC Reflectance | 2013 - present 2014 - present | 10 days | Global | 1 km 300 m* | SPOT/VGT PROBA-V* | 3 days |
| Surface Albedo | 1999 - present 2014 - present | 10 days | Global | 1 km 300 m* | SPOT/VGT PROBA-V* | 3 days |
| Land Surface Temperature | 2009 - present | 1 hour 10 days* | Global | 0.05° | ΣGeo | 1 day |
| Soil Water Index | 2007 - present 2015 - present | 1 day 10 days* | Global Europe | 0.1° 1 km* | Metop/ASCAT Sentinel-1* | 1 day |
| Water Bodies | 1999 - present 2014 - present | 10 days | Africa Global | 1 km 300 m* | SPOT/VGT PROBA-V | 3 days |

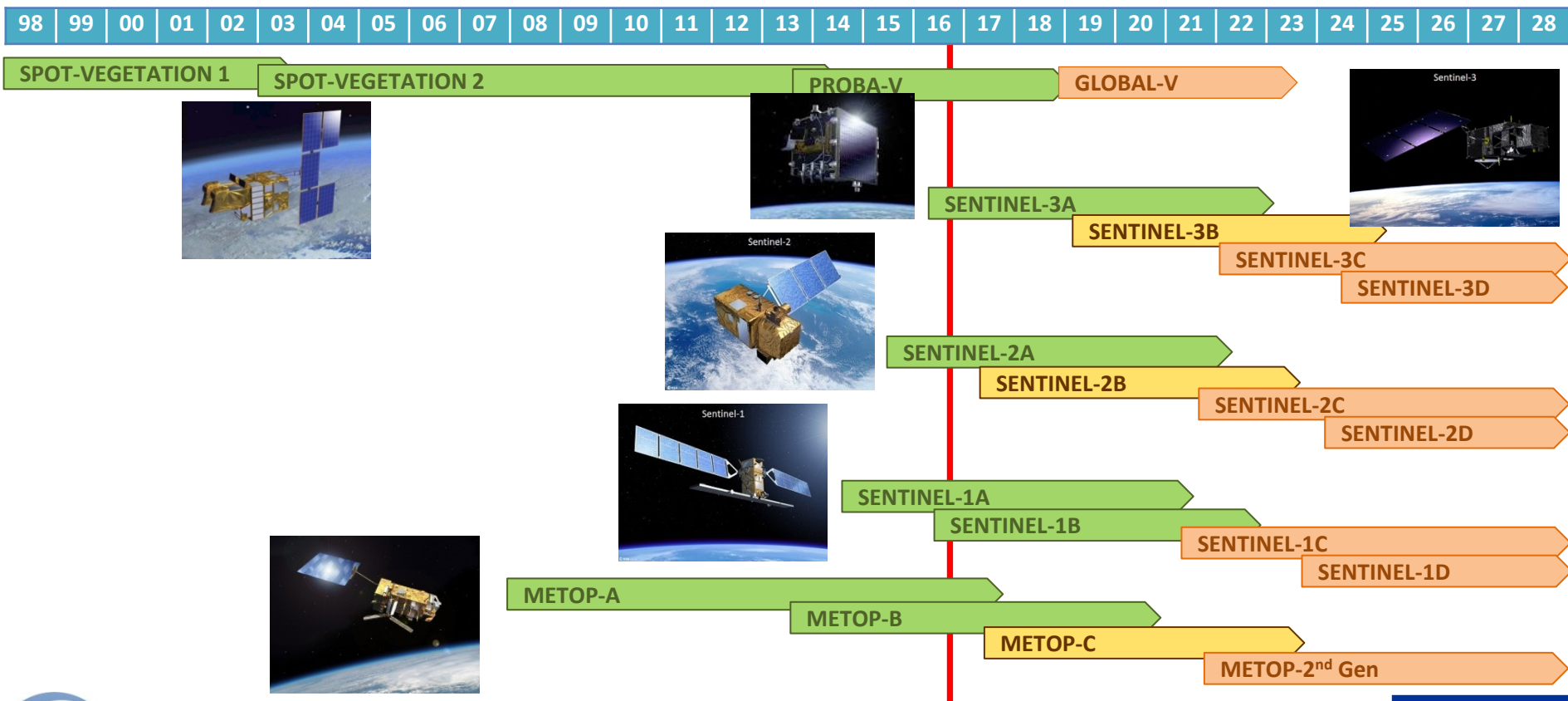
*In development

**processing started, coming soon

Ensure the consistency of time-series across sensors and resolutions

Continuity and Sustainability

Sensors for global ecosystems monitoring



Instruments characteristics

| | VGT2 on SPOT5 | VGT on PROBA | OLCI on S3 | MSI on S2 |
|--------------------------------------|--|---|---|-------------------------------------|
| Swath | 2250 km | 2295 km | 1270 km | 290 km |
| Instrument concept | Linear array of CCD detectors | 3 cameras with 2 focal planes (VNIR and SWIR) | 5 tilted cameras | Push broom imager |
| Local overpass time | 10:30 | 10:45 (drift from launch) | 10:00 | 10:30 |
| Revisit time (at the equator) | 2 days | 2 days | <2.2 days (S3A) <1.1 day (S3A + S3B) | 10 days (S2A) 5 days (S2A+S2B) |
| Spectral bands | Blue [0.43-0.47] Red [0.61 – 0.68] NIR [0.78-0.89] SWIR [1.58-1.75] | Blue [0.447-0.493] Red [0.61-0.69] NIR [0.77-0.893] SWIR [1.57-1.65] | 21 bands in the range [0.4 – 1.02] | 13 bands in the range [0.43 – 2.28] |
| Spatial Resolution | 1.15km | VNIR: 100m nadir; 333m edge SWIR: 200m nadir; 666m edge | 300m | 10m, 20m, 60m depending on bands |

Different concepts and designs

PROBA-V vs SPOT/VGT: similar but not identical

Missions products

| | SPOT/VGT | PROBA-V | Sentinel-3 | Sentinel-2 |
|-------------------------------|--|-----------------------------------|--|----------------------------|
| L1B: TOA radiances | | | OLCI & SLSTR | Granules |
| L1C : TOA reflectances | VGT-P (segments) | Segments and daily synthesis (S1) | VGT-P like (1km) | Tiles |
| L2: TOC reflectances | daily (S1) and 10-days (S10) synthesis | S1 and S10 synthesis | SYN=OLCI+SLSTR (300m) VGT-S1 & VGT-S10 like (1km) | (using Sentinel-2 Toolbox) |

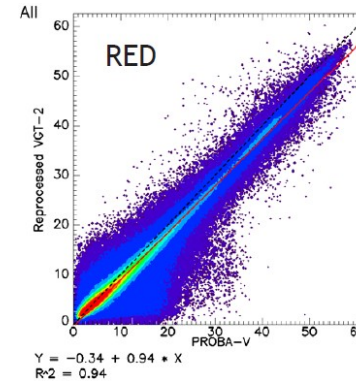
Similar product levels but different processing, e.g. for atmospheric correction, time compositing, ...

Statement

- **Given**

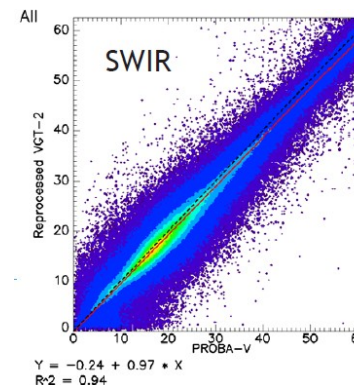
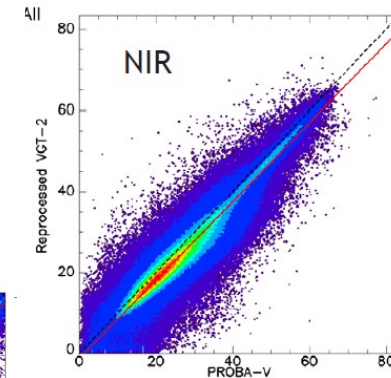
- the different concepts and designs of EO sensors
- the different processing in ground segments
- the lack of harmonized products across-missions (e.g. inter-calibrated reflectances)
- the different grids, projections and formats

- **It is very challenging to retrieve consistent long time series of land surface biophysical variables**



Similarity between PROBA-V and VGT:

- view zenith angle <30°
- same view azimuth angle



How to deal with these differences?

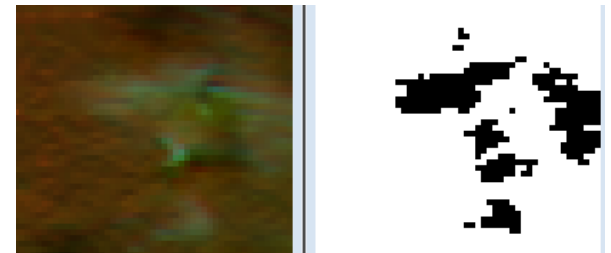
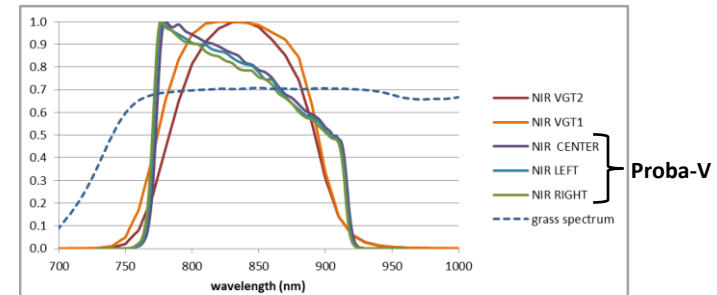
- **Define and apply spectral corrections**

- On TOA and TOC reflectances
- On NDVI

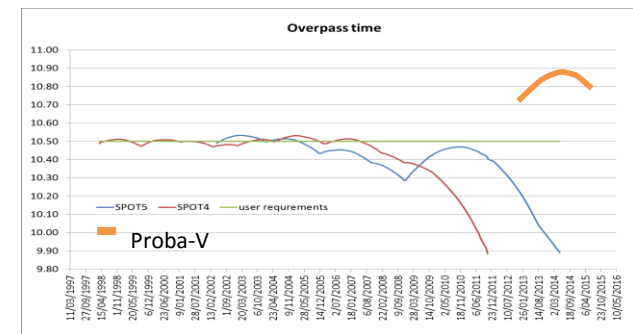
- **Adapt the thresholds for detection of contaminated pixels (snow, clouds, shadows)**

- **Add a module in retrieval algorithm to rescale the PROBA-V estimates of vegetation variables to VGT estimates**

- **Use BRDF correction to remove the differences in overpass time**



Detection of thin clouds (in black)



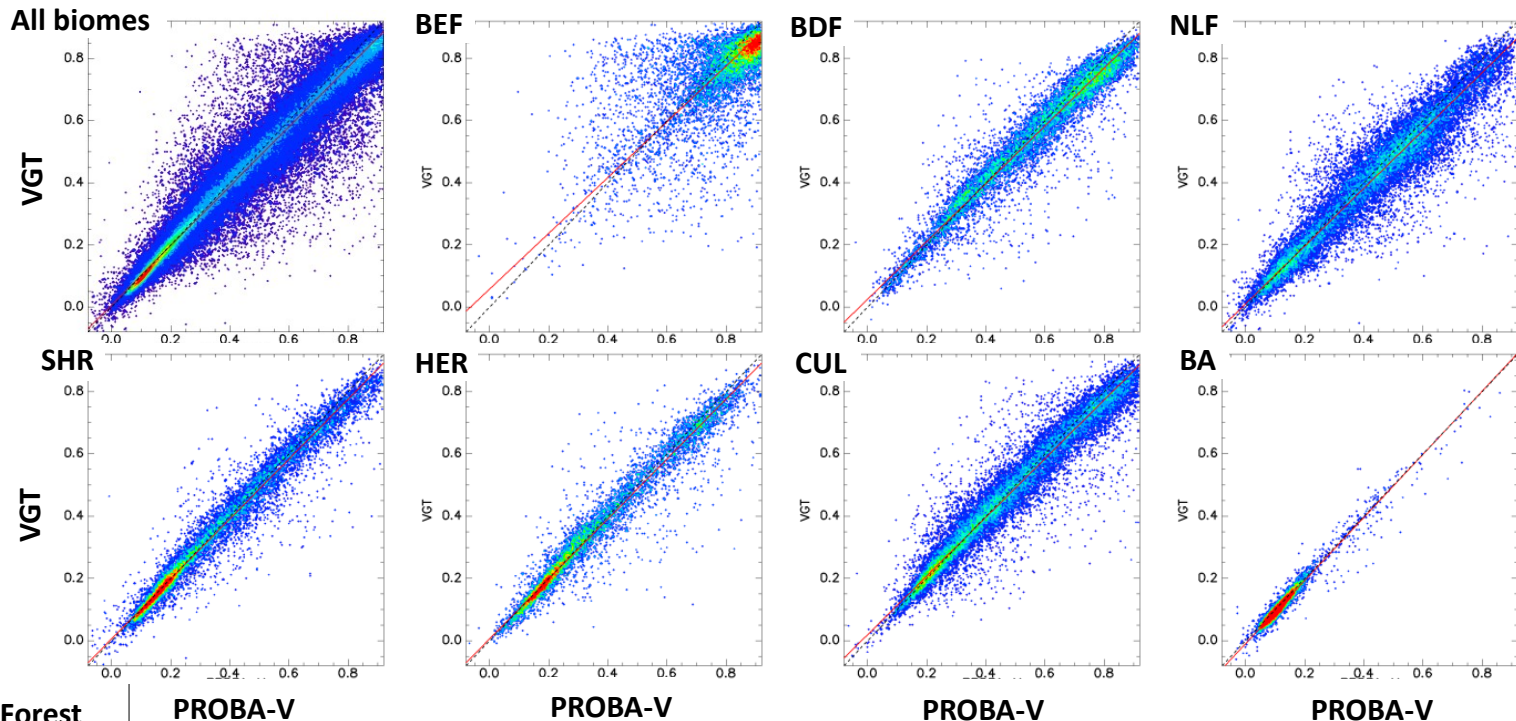
When it is not enough

- **Request to adapt the compositing rule in PROBA-V ground segment to make the S1 and S10 more compliant with SPOT-VGT**
 - Implemented in June 2014; re-processing in Sept 2014.
- **Request to access PROBA-V Level 2a (instantaneous TOA reflectances) closer to SPOT/VGT P segments**
 - Access granted with Collection 1

Impact on NDVI

$$NDVI = \frac{REF_{NIR} - REF_{RED}}{REF_{NIR} + REF_{RED}}$$

The most widely used vegetation index

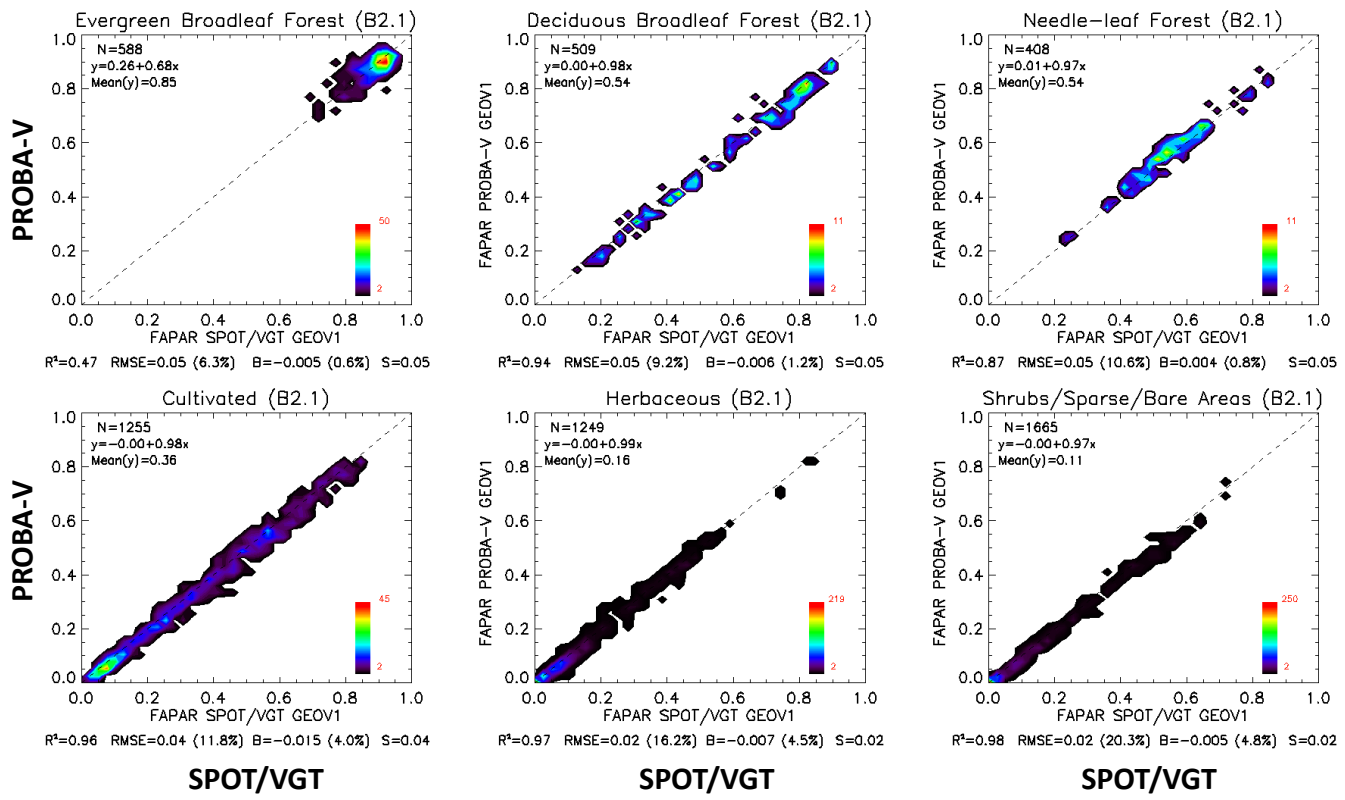


From GIOGL1_QAR_NDVI-VCI-VPI1km-V2_I1.21.pdf
available on <http://land.copernicus.eu/global/>

- Global & overlap period (Nov'2013 – May 2014)
- Good agreement for low values, PV slightly overestimates high values

Impact on FAPAR

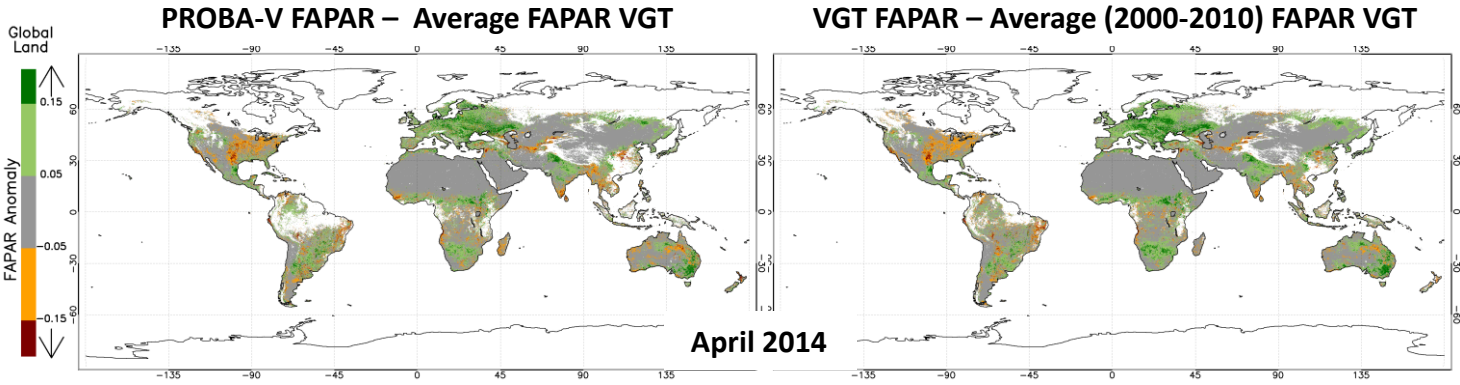
FAPAR is the fraction of sun radiation used by vegetation for the photosynthesis



From GIOGL1_QAR_FAPAR1km-V1_I1.30.pdf available on <http://land.copernicus.eu/global/>

- Global & overlap period (Nov'2013 – May 2014)
- Good agreement, within GCOS requirements (RMSE < 0.05)

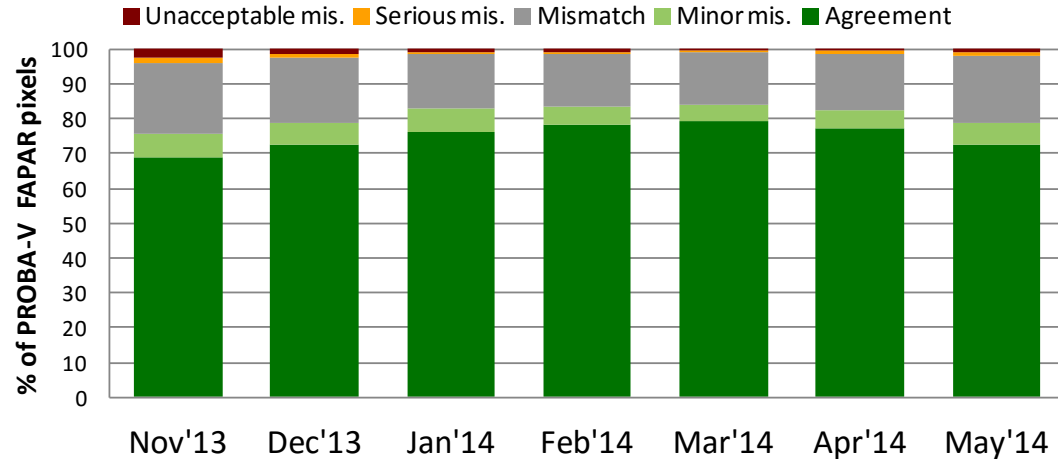
Impact on FAPAR anomalies



| Anomaly Classes | FAPAR diff. with VGT Climato |
|-----------------|------------------------------|
| Large increase | >0.15 |
| Small increase | [0.05, 0.15] |
| No change | [-0.05, 0.05] |
| Small decrease | [-0.15, -0.05] |
| Large decrease | <-0.15 |

From GIOGL1_QAR_FAPAR1km-V1_I1.30.pdf available on <http://land.copernicus.eu/global/>

FAPAR anomaly compares the current health condition of vegetation with an average



| Agreement for Classes | Condition |
|-----------------------|--|
| Agreement | Same class of anomaly |
| Minor mismatch | Same sign of anomaly, but different magnitude ("small" vs "large") |
| Mismatch | One is "no change" and the other is "small" change (either increase or decrease) |
| Serious mismatch | One is "no change" and the other is "large" change (either increase or decrease) |
| Unacceptable mismatch | Anomalies with opposite sign (any magnitude) |

From Meroni et al., IEEE TGRS, 2016

Sensor transition may cause artificial anomalies

Lessons learnt

- **Too many differences in sensor designs and data processing make full agreement across missions difficult**
- **The assumptions “*PROBA-V is VGT-like*” and “*S3 SYN is VGT-like*” are not true**
- **It takes time to adapt methodologies to new sensors data to ensure the time series consistency as well as possible**
- **Users must be aware of these limitations and of the impact on anomalies**

Conclusions & Recommendations

- **Not all input data differences can be corrected with biophysical retrieval algorithms**
 - ⇒ Unavoidable discrepancies in time series
- **Users must accept these discrepancies**
- **Harmonization across missions (SPOT/VGT, PROBA-V, S3, S2) and resolutions (1km, 300m, 100m) is required:**
 - Mission-specific data is not sufficient
 - Inter-calibration of reflectances, similar pre-processing (e.g atmospheric corrections), equivalent grid, projections, format
 - Inter-calibration requires enough overlap across missions
 - Close cooperation between missions/ground segments is mandatory
 - Reprocessing of historic archives should be planned regularly

Website <http://land.copernicus.eu/global>

Copernicus Global Land Service
Providing bio-geophysical products of global land surface



[About](#) | [Contact us](#)

- Home
- Products**
- News
- Product Access
- Viewing

Vegetation

Water

Energy

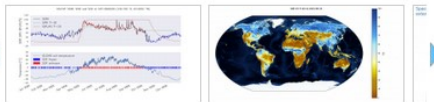
Home

The Global Land Service is a component of the Copernicus Land service that provides a series of bio-geophysical products on the status and evolution of land surface at global scale at mid and low spatial resolution. Production and delivery of the parameters take place in a timely manner and are complemented by the constitution of long term time series. The products are used to monitor the vegetation, the water cycle and the energy budget.

125 sq Kilometres
burnt in Australia in early January 2015

1300th
user registered for online access

8.7 TB
downloaded in 2nd quarter 2016



Latest news

- Global Land Seminar at CREAM, Spain
Mon, 10 Oct 2016
- First SWI Time Series product available
Thu, 01 Sep 2016
- Release of three SWI static layers
Tue, 28 Jun 2016
- Stop of SWI version 2 on July 12, 2016
Tue, 28 Jun 2016

User support corner

- Leaflet
- Product portfolio
- Contact us
- FAQ

Copernicus Global Land Service
Providing bio-geophysical products of global land surface



[About](#) | [Contact us](#)

- Home
- Products
- News
- Product Access
- Viewing

LAI

VPI

FAPAR

VCI

FCOVER

DMP

NDVI

Burnt Area

Fraction of Absorbed Photosynthetically Active Radiation

The FAPAR quantifies the fraction of the solar radiation absorbed by live leaves for the photosynthesis activity. Then, it refers only to the green and alive elements of the canopy. The FAPAR depends on the canopy structure, vegetation element optical properties, atmospheric conditions, and angular configuration. To overcome this latter dependency, a daily integrated FAPAR value is assessed.

FAPAR is recognized as an Essential Climate Variable (ECV) by the Global Climate Observing System (GCOS).

FAPAR Alerts

- Two corrupt FAPAR AFRI continent products
Mon, 13 Jun 2016
 - FAPAR v1 over Africa available on EUMETCast
Fri, 28 Aug 2015
 - FAPAR version 1 archive completed
Fri, 03 Jul 2015
 - FAPAR version 1 resumes
Wed, 08 Apr 2015
- [Read more](#) or [Subscribe](#)

FAPAR characteristics

| Product version | Access | Status | Sensor | Temporal coverage | Spatial information | Timeliness |
|-----------------|------------------|-----------------|-------------------|---------------------|---|---|
| 2 | Expected Q4 2016 | In development | SPOT-VGT, PROBA-V | 1999 - present | Global, 1km | Within 3 days after end of synthesis period |
| 1 | Product Portal | Operational | SPOT-VGT | Dec 1998 - May 2014 | Global, 10°x10° tiles, continental tiles, 1km | Archive only |
| 1 | Product Portal | Pre-operational | PROBA-V | Jun 2014 - present | Global, 10°x10° tiles, continental tiles, 1km | Within 3 days after end of synthesis period |

For access via GEONETCast satellite broadcast, please register for Global Land products on EUMETSAT's EO Portal. If you're looking for information on older product versions, please contact us.



Bright Side of Remote Sensing – Brussels – 25th October 2016



Website <http://land.copernicus.eu/global>

The screenshot displays the Copernicus Land Monitoring Service interface. On the left, a sidebar lists biophysical parameters under 'Vegetation', including Dry Matter Prod..., FAPAR (Version 1), FCOVER, Leaf Area Index, and NDVI. The 'Time' section shows a list of years from 2006 to 2016, with 2016 selected. Below this, there are sections for 'Country', 'Admin level 1', and 'LandCover'. The main area features a world map showing FAPAR_V1 values, with a legend on the right ranging from 0 to 1. A date selector at the top left of the map shows '2016-05-11' and 'Product type: FAPAR_V1'. Below the map, there are navigation options for 'Charts', 'Charts per region', 'Monthly maps', and 'Charts per land cover'. The selected chart is titled 'Belgium, 2016'. It includes a zoom control (1m, 3m, 6m, YTD, 1y, All) and a date range selector (From Dec 31, 2015 To Sep 21, 2016). The chart shows FAPAR_V1 values over time, with a red vertical line indicating the current date. The legend for the chart includes FAPAR_V1 (solid green line), FAPAR_V1 Min (dashed green line), FAPAR_V1 Max (dotted green line), and FAPAR_V1 LTA (dashed blue line). The bottom of the page contains the Copernicus logo and the text 'The European Earth Observation Programme'.

Website <http://land.copernicus.eu/global>

Copernicus Global Land Service

Providing bio-geophysical products of global land surface



About | Contact us

- Home
- Products
- News
- Product Access**
- Viewing



- Vegetation**
- Water**
- Energy**

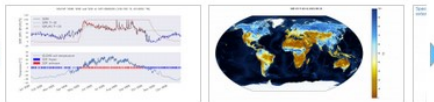
Home

The Global Land Service is a component of the Copernicus Land service that provides a series of bio-geophysical products on the status and evolution of land surface at global scale at mid and low spatial resolution. Production and delivery of the parameters take place in a timely manner and are complemented by the constitution of long term time series. The products are used to monitor the vegetation, the water cycle and the energy budget.

Latest news

- Global Land Seminar at CREAL, Spain
Mon, 10 Oct 2016
- First SWI Time Series product available
Thu, 01 Sep 2016
- Release of three SWI static layers
Tue, 28 Jun 2016
- Stop of SWI version 2 on July 12, 2016
Tue, 28 Jun 2016

- 125 sq Kilometres burnt in Australia in early January 2015
- 1300th user registered for online access
- 8.7 TB downloaded in 2nd quarter 2016



User support corner

- Leaflet
- Product portfolio
- Contact us
- FAQ

Copernicus Global Land Service

Providing bio-geophysical products of global land surface



About | Contact us

- Home
- Products
- News
- Product Access**
- Viewing

| | |
|--------|------------|
| LAI | VPI |
| FAPAR | VCI |
| FCOVER | DMP |
| NDVI | Burnt Area |

Fraction of Absorbed Photosynthetically Active Radiation

The FAPAR quantifies the fraction of the solar radiation absorbed by live leaves for the photosynthesis activity. Then, it refers only to the green and alive elements of the canopy. The FAPAR depends on the canopy structure, vegetation element optical properties, atmospheric conditions, and angular configuration. To overcome this latter dependency, a daily integrated FAPAR value is assessed. FAPAR is recognized as an Essential Climate Variable (ECV) by the Global Climate Observing System (GCOS).

FAPAR Alerts

- Two corrupt FAPAR AFRI continent products
Mon, 12 Jun 2016
- FAPAR v1 over Africa available on EUMETSAT
Fri, 28 Aug 2015
- FAPAR version 1 archive completed
Fri, 03 Jul 2015
- FAPAR version 1 resumes
Wed, 08 Apr 2015

FAPAR characteristics

| Product version | Access | Status | Sensor | Temporal coverage | Spatial information | Timeliness |
|-----------------|------------------|-----------------|-------------------|---------------------|---|---|
| 2 | Expected Q4 2016 | In development | SPOT-VGT, PROBA-V | 1999 - present | Global, 1km | Within 3 days after end of synthesis period |
| 1 | Product Portal | Operational | SPOT-VGT | Dec 1998 - May 2014 | Global, 10°x10° tiles, continental tiles, 1km | Archive only |
| 1 | Product Portal | Pre-operational | PROBA-V | Jun 2014 - present | Global, 10°x10° tiles, continental tiles, 1km | Within 3 days after end of synthesis period |

For access via EUMETSAT satellite broadcast, please register for Global Land products on EUMETSAT's EO Portal. If you're looking for information on older product versions, please contact us.



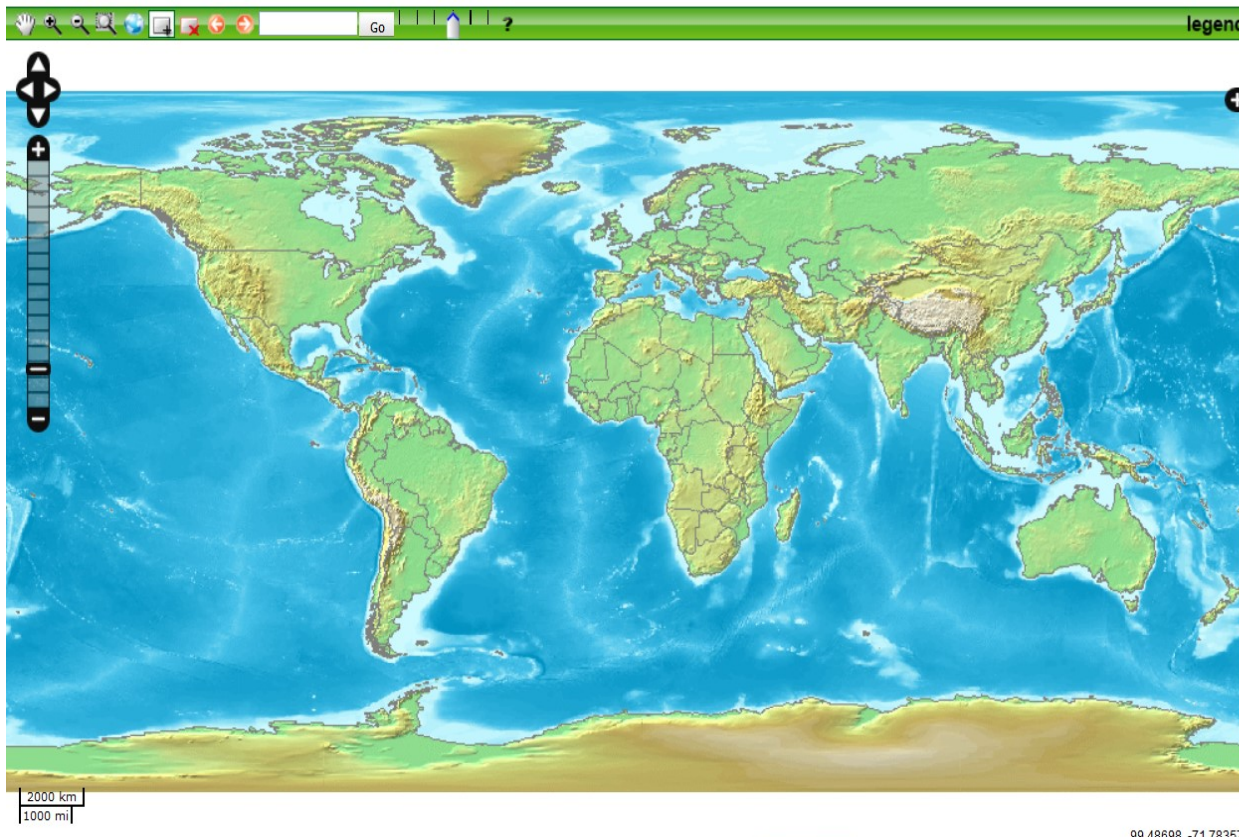
Data portal: free and open access

Copernicus Global Land Service

Providing bio-geophysical products of global land surface



Login Help Register FAQ Contact



Watch our video tutorials



Catalogue search **Subscription**

Vegetation Properties - FAPAR 1km V1

Help

Collection

- LAI 1km V1 (4481 products)
- FCOVER 1km V1 (4479 products)
- FAPAR 1km V1 (4478 products)

Basic

| Date | Slot |
|------------|------------|
| Start date | 01/06/2014 |
| End date | 31/12/2020 |

ROI

Coverage

- BioPar_FAPAR_V1_Tiles
- BioPar_FAPAR_V1_CONTINENTS

Advanced

Search Reset

Number of results per page 100



Bright Side of Remote Sensing – Brussels – 25th October 2016



Contacts

Thank you for your attention!

Implementation coordination:

copernicuslandproducts@jrc.ec.europa.eu



• Global Land Operations

- Consortium "Production of vegetation & energy products" led by VITO



Coordinator: Bruno Smets – VITO bruno.smets@vito.be

S&T contact: Roselyne Lacaze – HYGEOS - rl@hygeos.com

Helpdesk: helpdeskticket@vgt.vito.be

- Consortium: "Production of Cryosphere & water products" led by CLS
- Consortium: "Distribution" led by VITO
- Consortium: "Evaluation & User group" led by Spacebel



• Hot Spot Monitoring

- Consortium «Mapping» led by eGEOS
- Consortium «Validation» led by IGT

• In-situ Ground Observations (TBD)

• S2 pre-processing (applications ready data) (in prep.)

