The EUMETSAT Network of Satellite Application Facilities

LSA SAF
Land Surface Analysis

Vegetation monitoring in the framework of EUMETSAT Land Surface Analysis SAF (land-SAF/LSA-SAF):

Alirio Arboleda
Based on material provided by:
F. Javier García-Haro (University of Valencia, Spain) and
Carla Barroso (IPMA, Portugal)

LSA-SAF MSG Products

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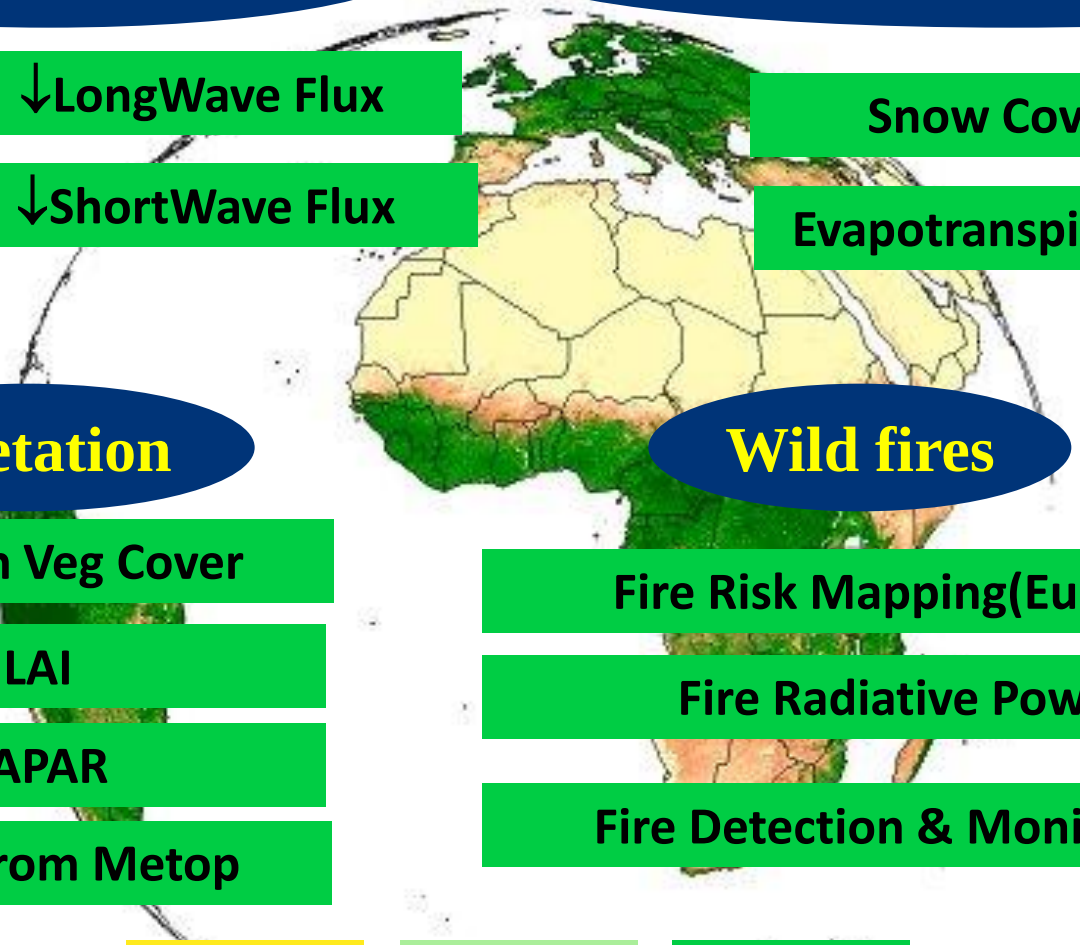
LSA SAF Land Surface Analysis

Surface Radiation

- LST
- Albedo
- ↓LongWave Flux
- ↓ShortWave Flux

Surface Water Balance

- Snow Cover
- Evapotranspiration



Vegetation

- Fraction Veg Cover
- LAI
- FAPAR
- NDVI from Metop

Wild fires

- Fire Risk Mapping(Europe)
- Fire Radiative Power
- Fire Detection & Monitoring

Development | Pre. Operat. | Operational

Increased level of maturity

Outline

- Basic Principles (Spectral signatures)
- MSG channels for vegetation monitoring
- Land SAF vegetation products (FVC, LAI, fAPAR)
  - Products characteristics
  - Products validation and quality assessment
  - Potential applications

Physical principles

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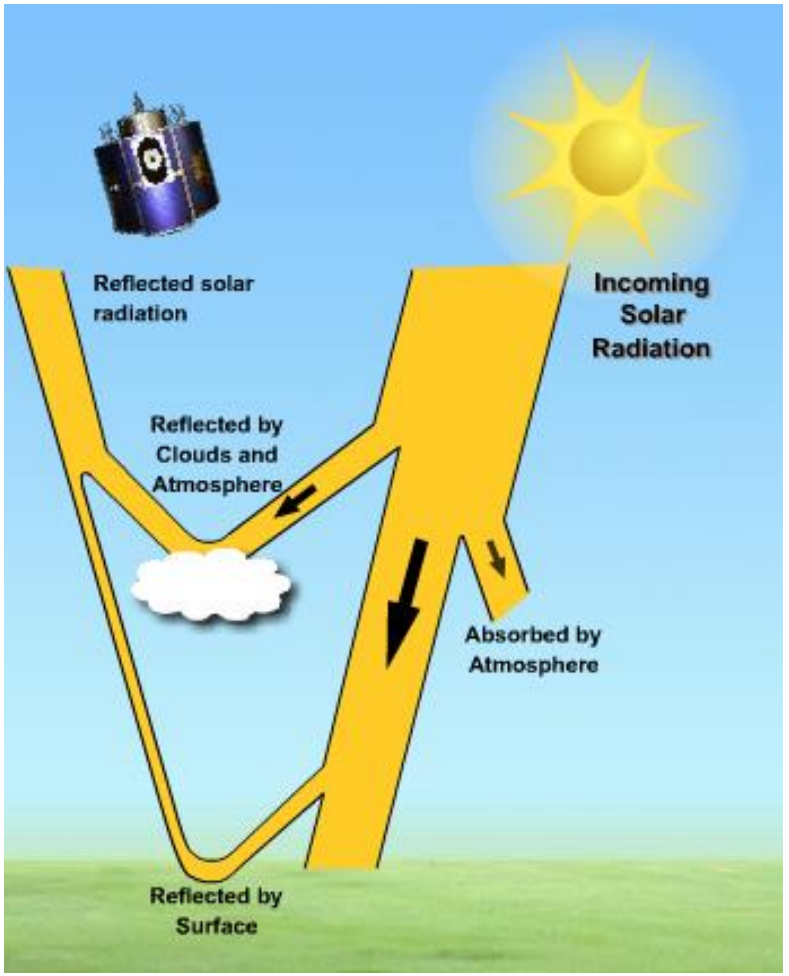
- **Spectral Signatures**

- Different materials **reflect** and **absorb** differently at different wavelengths.

- Have different **spectral signatures**.

- Enables to distinguish the different features from remotely sensed data.



Spectral Signatures

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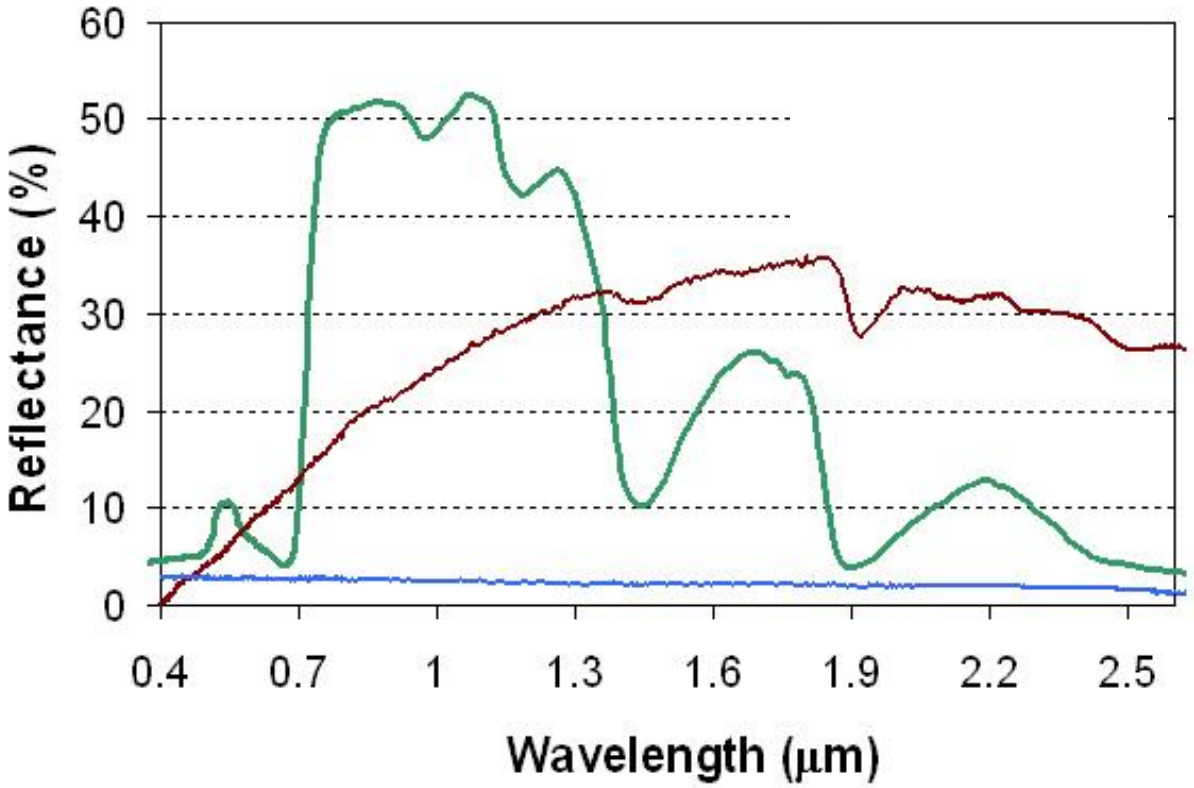
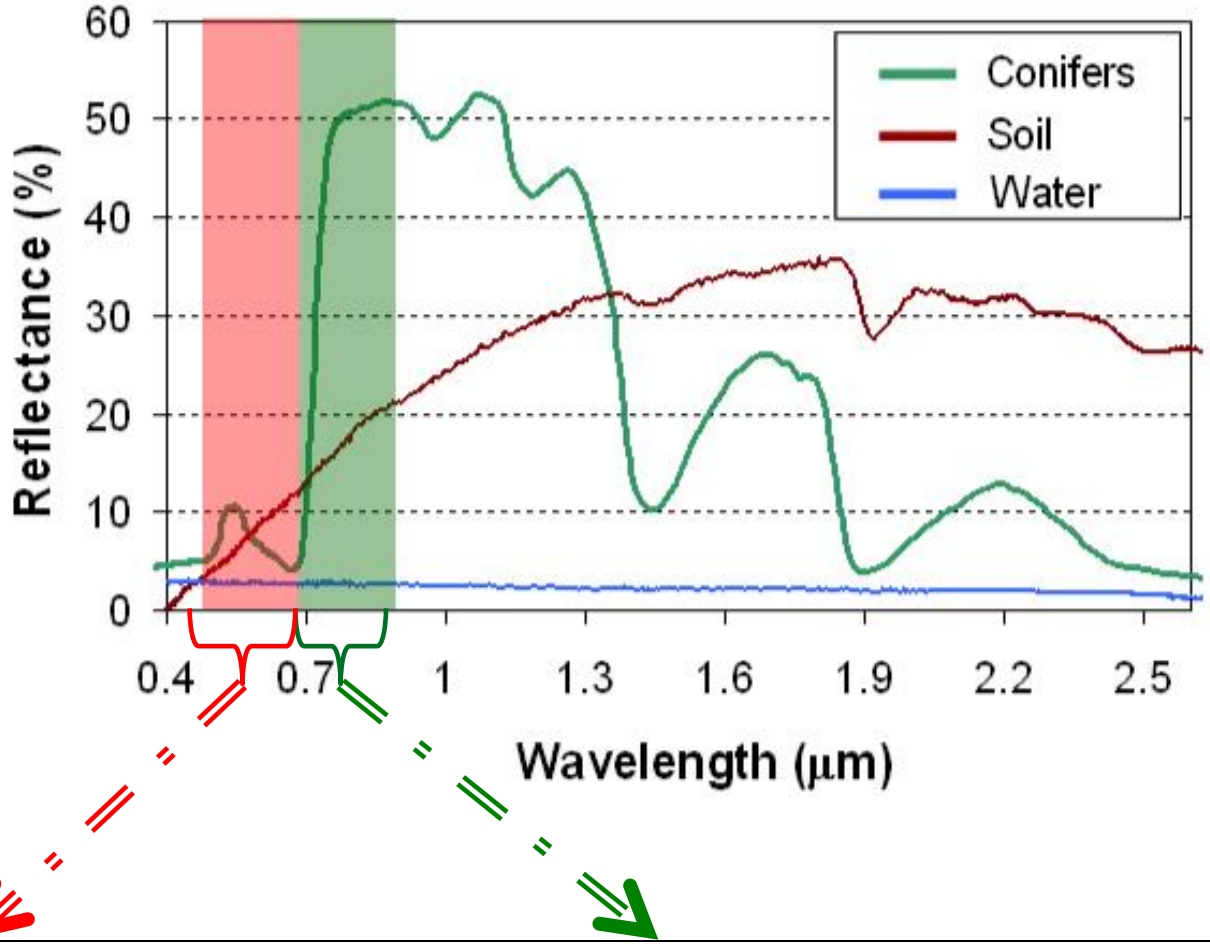
LSA SAF Land Surface Analysis

Spectral Signature
Or
Spectral response curves



Spectral Signatures

Spectral Signature
Or
Spectral response curves

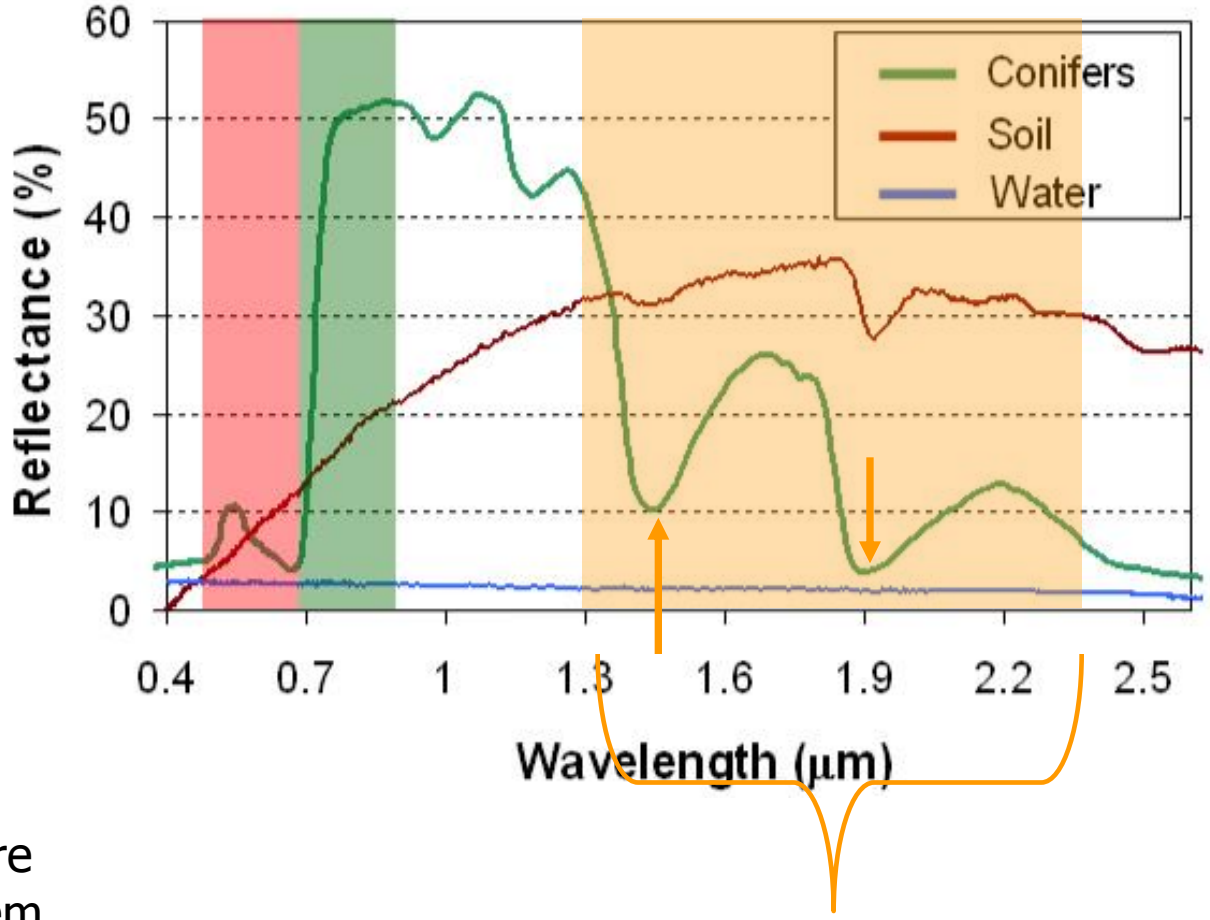


Strong absorption
(reflectance peak at 0.55 μm)

High reflectance in the NIR (0.8 μm)

Spectral Signatures

Spectral Signature
Or
Spectral response curves

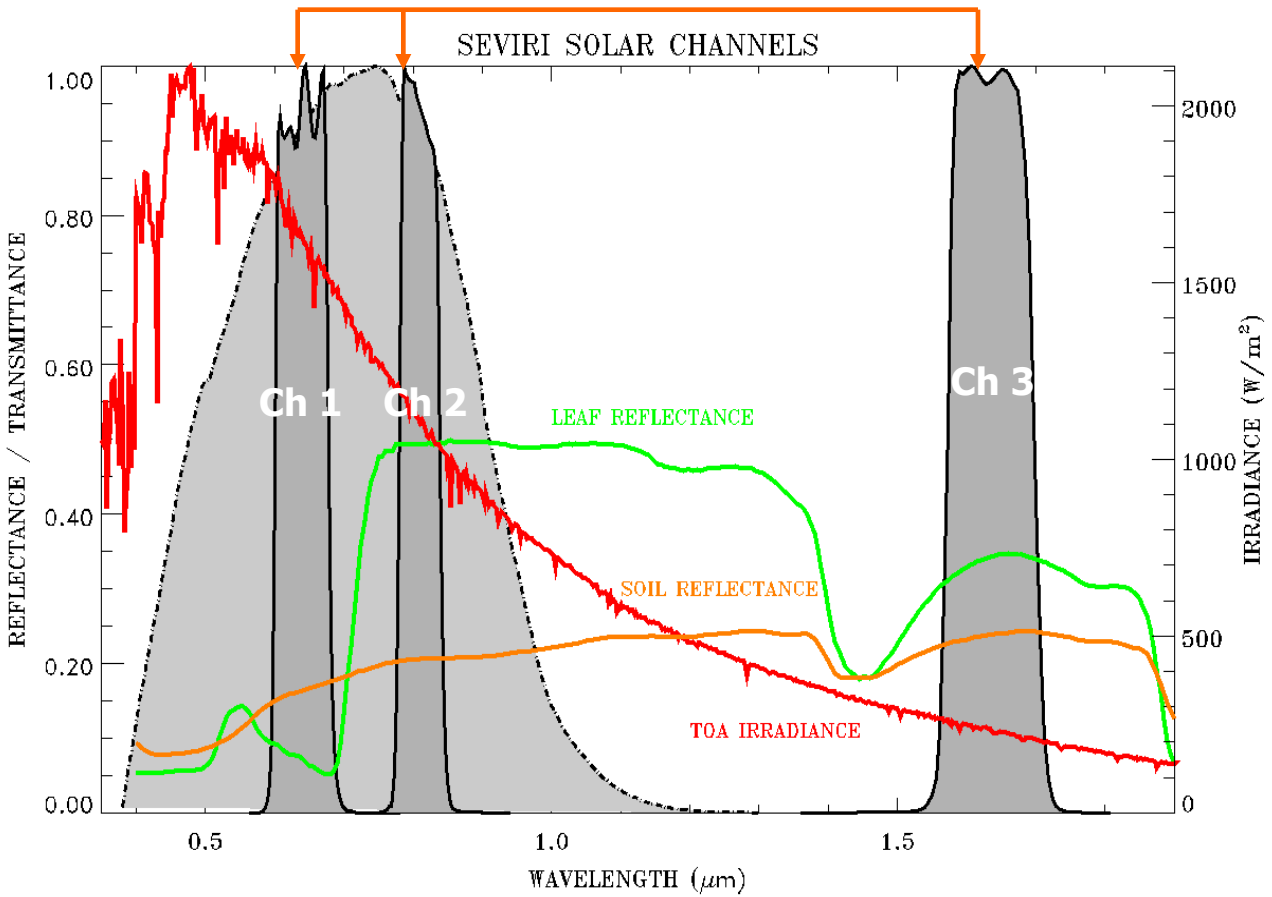


To identify the spectral signature of a material, the sensing system need to have enough spectral resolution in order to distinguish its spectrum from those of other materials!

absorption by water, cellulose and lignin and several other biochemical constituents

MSG channels for vegetation monitoring

SEVIRI spectral response functions



Source: http://www.eumetrain.org/resources/operational_use_rgb.html

MSG channels for vegetation monitoring

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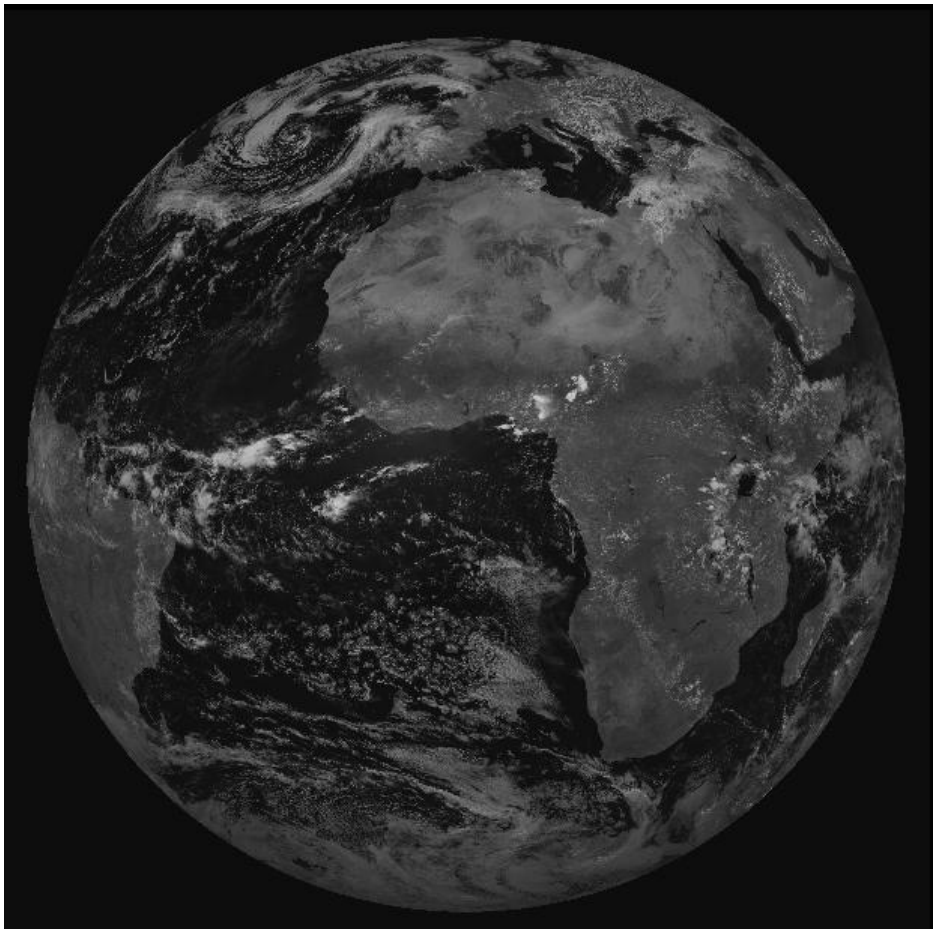
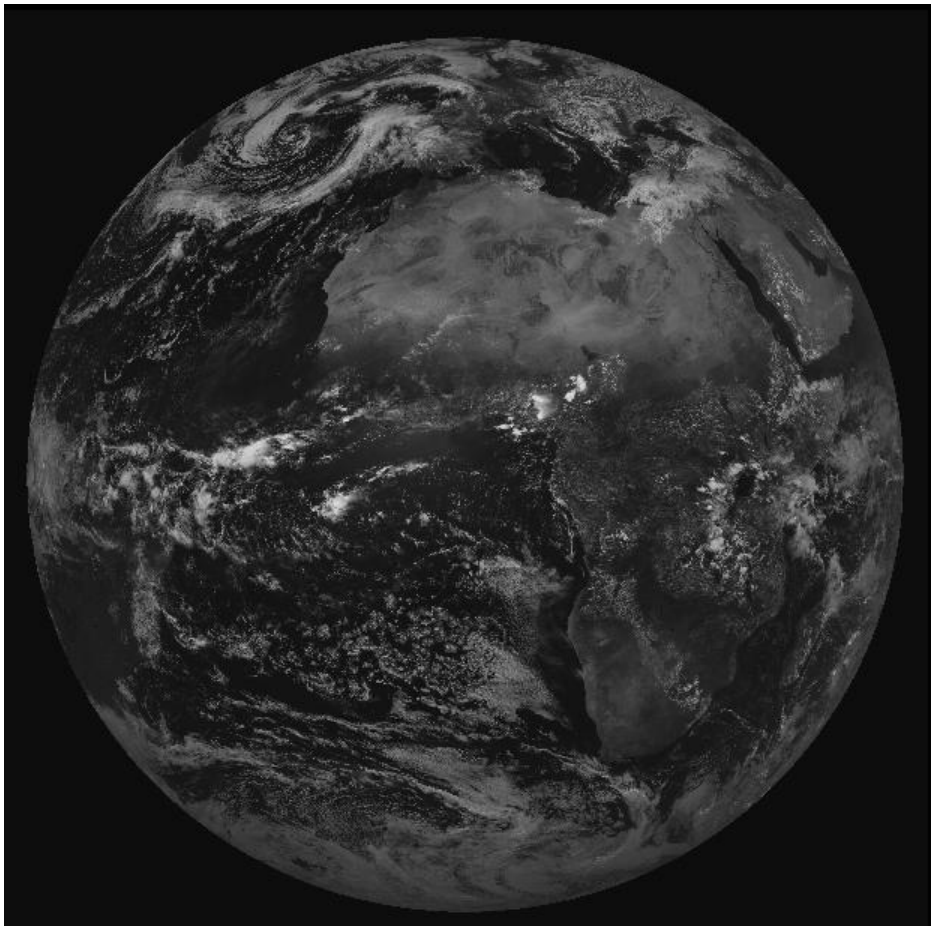
LSA SAF Land Surface Analysis

Which of the images correspond to MSG 0.8μm channel?



A



B

MSG channels for vegetation monitoring

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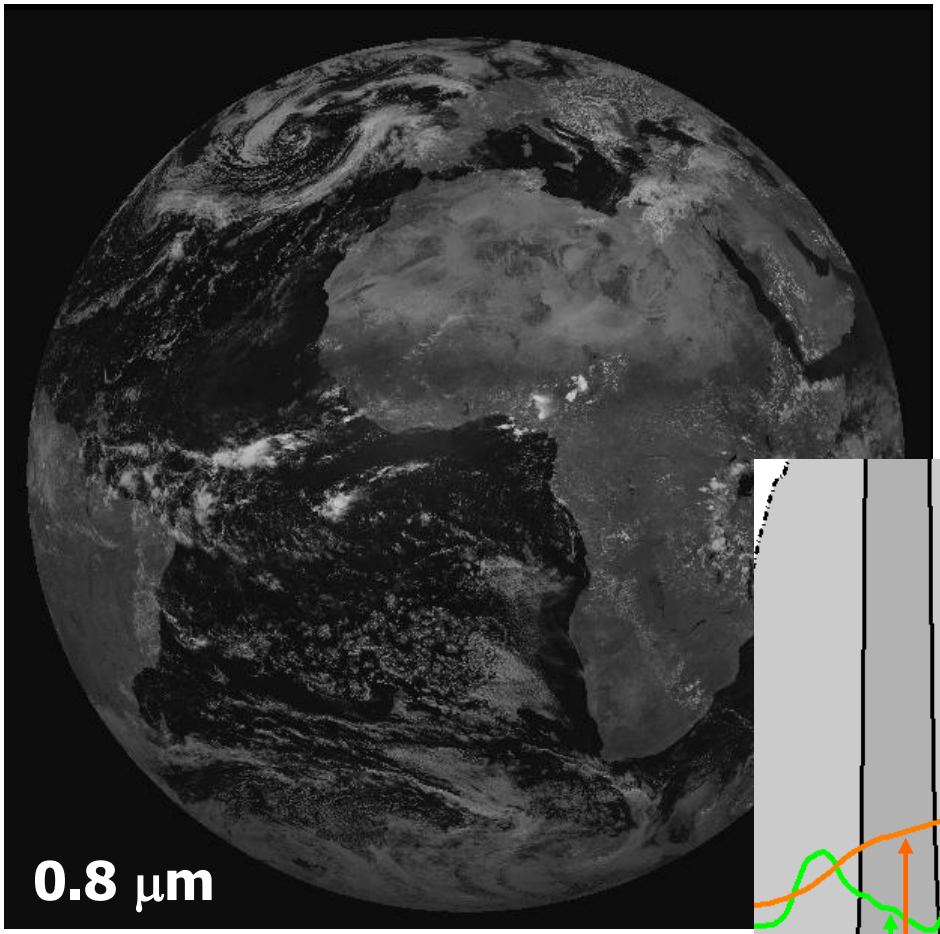
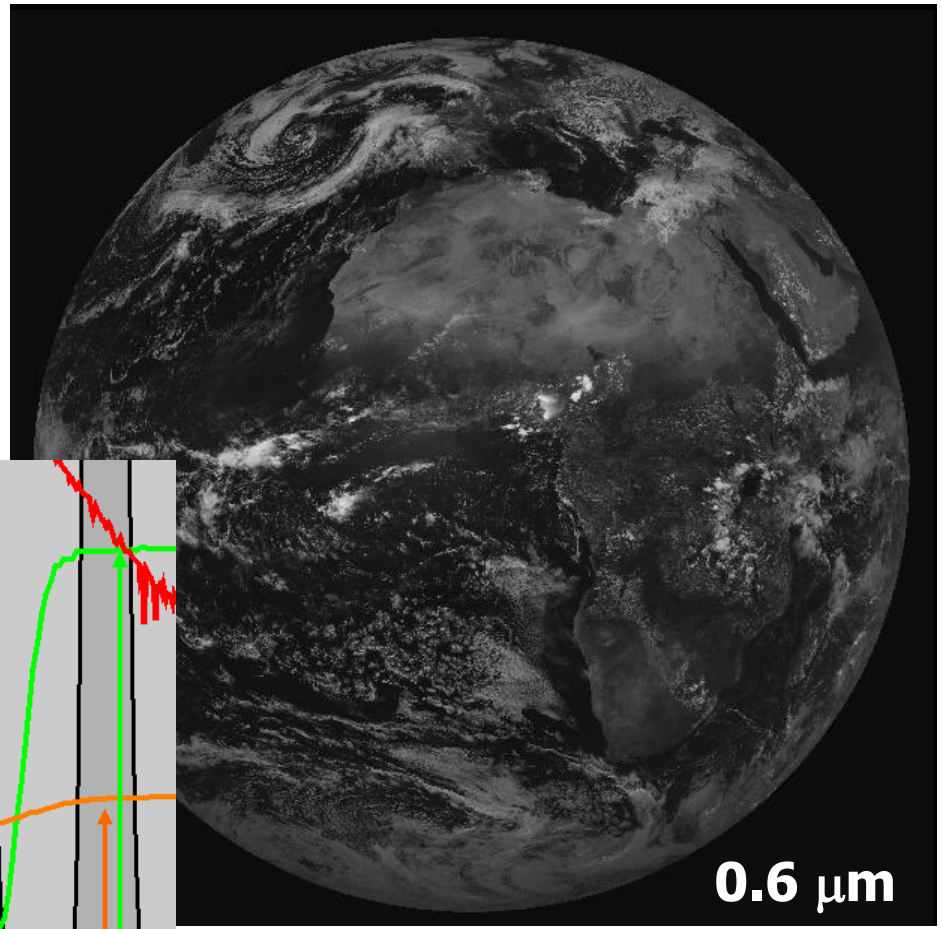
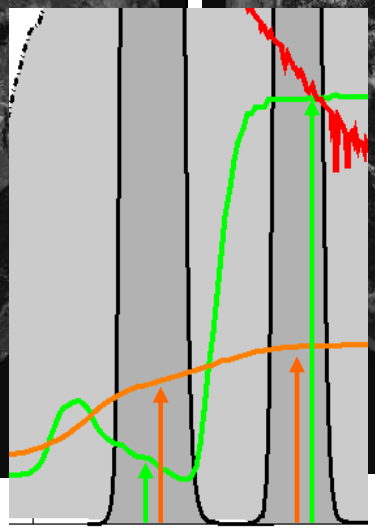
LSA SAF Land Surface Analysis

Which of the images correspond to MSG 0.8μm channel?

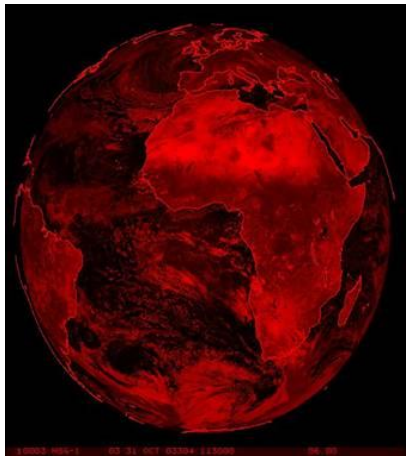




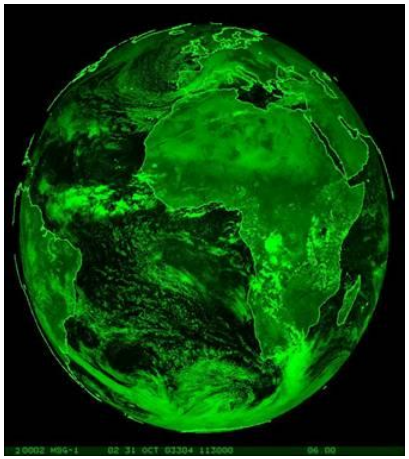


RGB Techniques

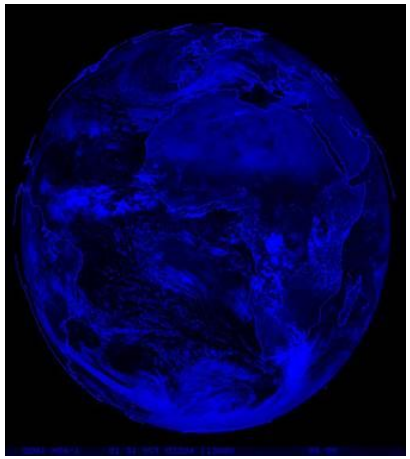
RGB Techniques – works by associating a colour to a particular channel



Red - MSG 1.6 μm



Green - MSG 0.8 μm

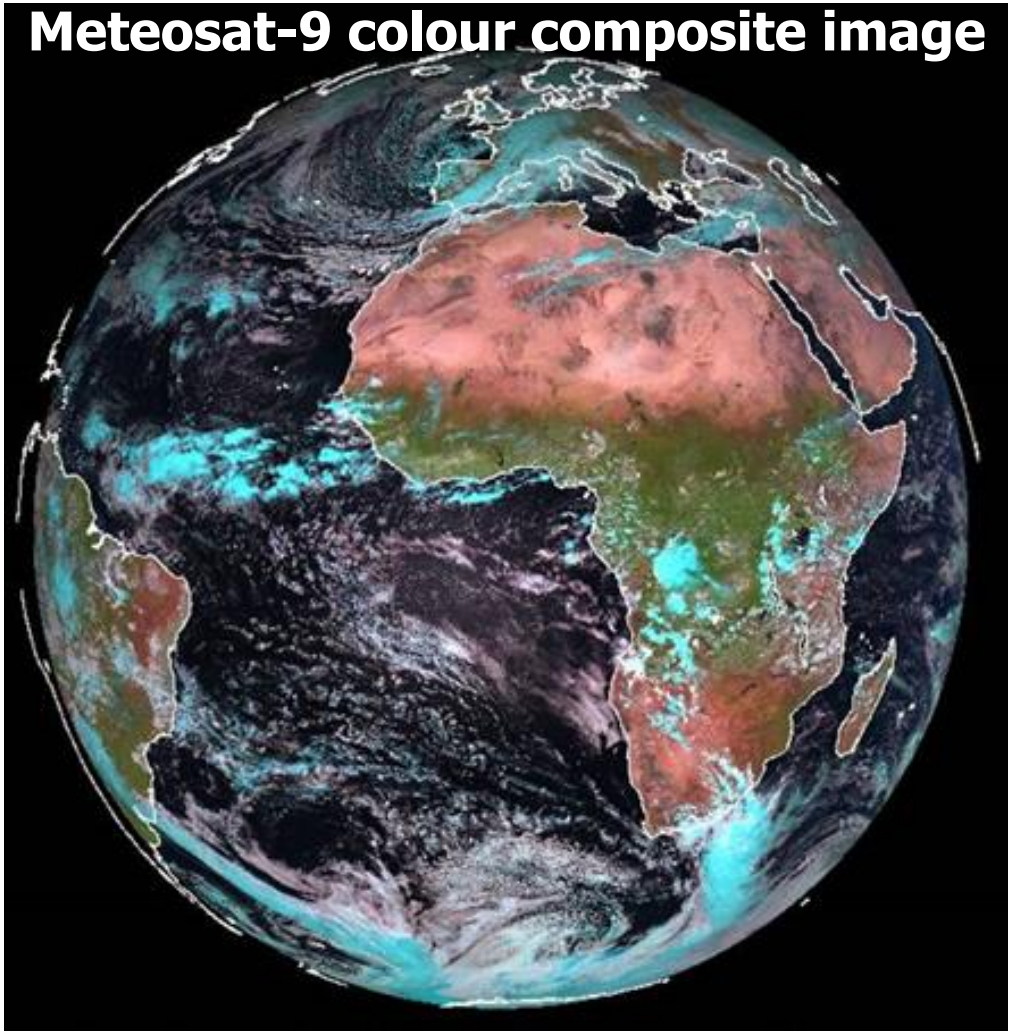


Blue - MSG 0.6 μm

Source: http://www.eumetrain.org/resources/operational_use_rgb.html

RGB Techniques

Natural colour



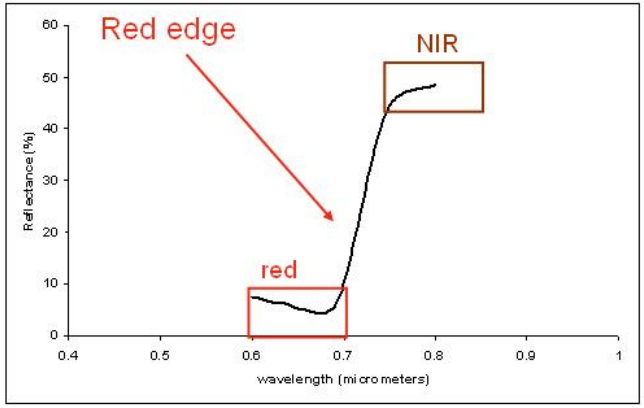
Red - 1.6 µm;
Green - 0.8 µm;
Blue - 0.6 µm

Source: http://www.eumetrain.org/resources/operational_use_rgb.html

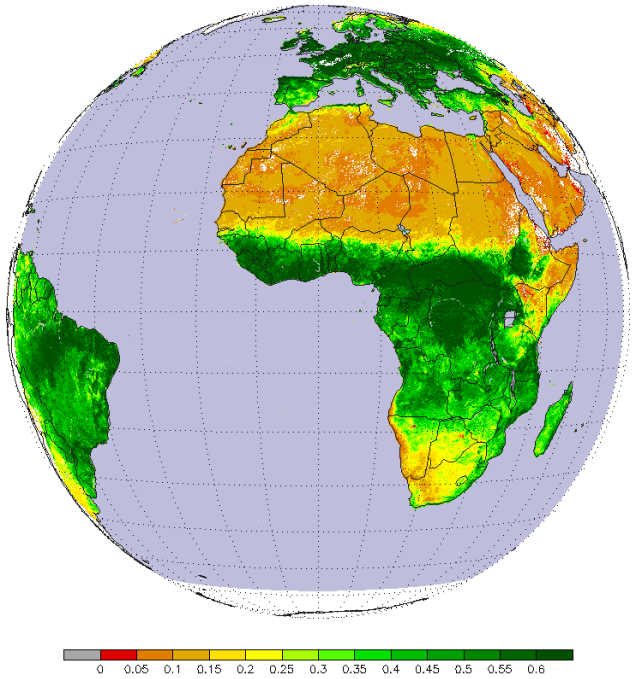
Vegetation Indices

$$NDVI = \frac{\rho_{channel2} - \rho_{channel1}}{\rho_{channel1} + \rho_{channel2}}$$

SEVIRI/MSG Channels 1 e 2 reflectances



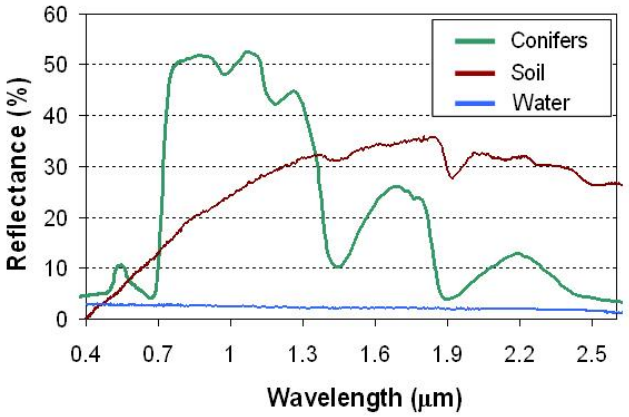
NDVI (15 June 2008)



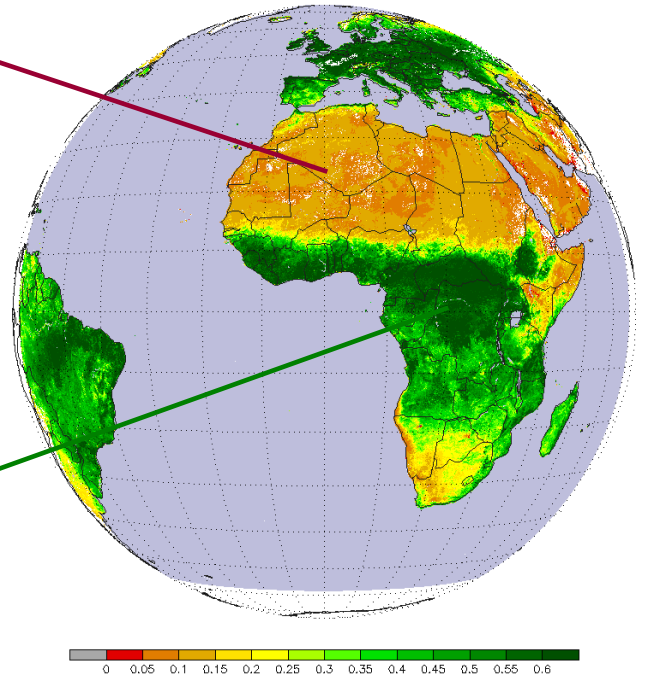
NDVI daily composite of SEVIRI full disk, June 15, 2008 (Source: Yu,Y. et al. Development of Vegetation Products for U.S. GOES-R Satellite Mission, Presented on 4th Global Vegetation Workshop Univ. of Montana, Missoula, June 16-19 2009

Vegetation Indices

For bare soil NDVI ~0



NDVI (15 June 2008)



For **vegetated** areas
NDVI ranges
between 0.2 and 0.6

NDVI daily composite of SEVIRI full disk, June 15, 2008 (Source: Yu,Y. et al. Development of Vegetation Products for U.S. GOES-R Satellite Mission, Presented on 4th Global Vegetation Workshop Univ. of Montana, Missoula, June 16-19 2009

Biogeophysical Parameters

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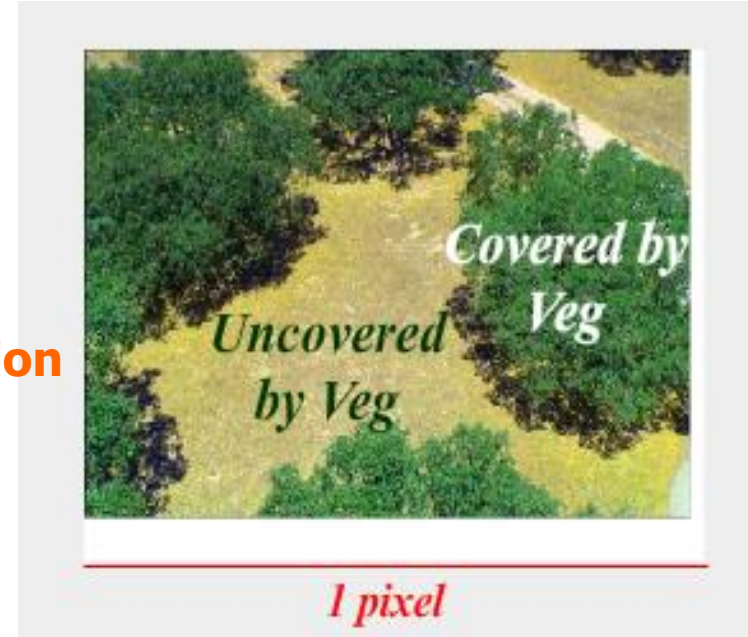
LSA SAF Land Surface Analysis

Parameters related to the structure of vegetated surfaces:

Fraction of Vegetation Cover (FVC): fraction of the surface covered by vegetation[0 – 1] and

Leaf Area Index (LAI): total area occupied by the leaves per unit area [m^2/m^2].

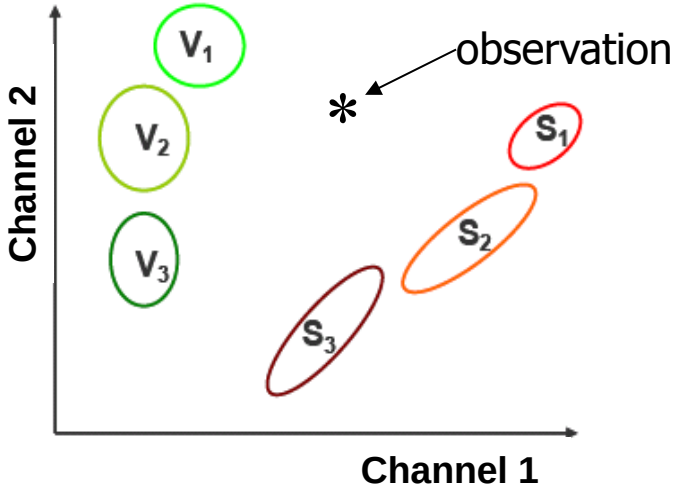


Parameter related with the state of vegetation

Fraction of Absorbed Photosynthetically Active Radiation (FAPAR): part of radiation used for photosynthesis (0.4 – 0.7μm) absorbed by the green parts of the canopy

LSA SAF FVC Algorithm

FVC, **LAI**, **FAPAR** are based in the analysis of vegetation signature in the **0.6 μm, 0.8 μm & 1.6 μm channels**.



- For any given observation (∗) the algorithm assumes this value can be modelled by the pairs (ρvegetation, ρsoilsubclass)
- The pure types, Vi and Si for **each pixel** are obtained by the **prevalent Land-cover**
- The distances between (∗) and Vi, Si give the fractions of each vegetation and soil type within the scene

$$FVC = \sum_{i=1}^{N} fvc_{Vi}$$

Number of vegetation subclasses present in the pixel

Fraction of vegetation cover for vegetation type Vi

Full description at http://landsaf.meteo.pt

LSA SAF LAI and fAPAR Algorithms

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LSA SAF Land Surface Analysis

LAI ESTIMATION

semi-empirical method in which LAI is related to FVC according to:

1) $$LAI = \frac{-1}{b.G(\theta s = 0).\Omega} \cdot \frac{\ln(a_0 - FVC)}{a}$$

B, G constants and
A_0, Ω coefficients depending on LandCover.

fAPAR ESTIMATION

estimated from a Renormalised Diference Vegetaioin index

2) $$RDVI = \frac{\rho_{channel2} - \rho_{channel1}}{\sqrt{\rho_{channel1} - \rho_{channel2}}}$$

View-illumination geometry
may have a large impact on reflectances

3) $$fAPAR = 1.81 RDVI_{opt} - 0.21$$

Biogeophysical Parameters

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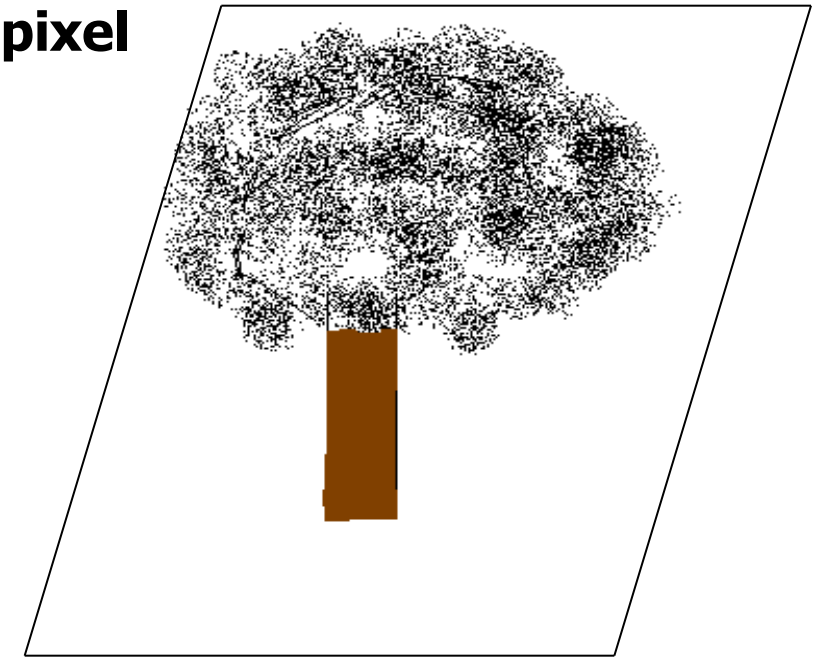
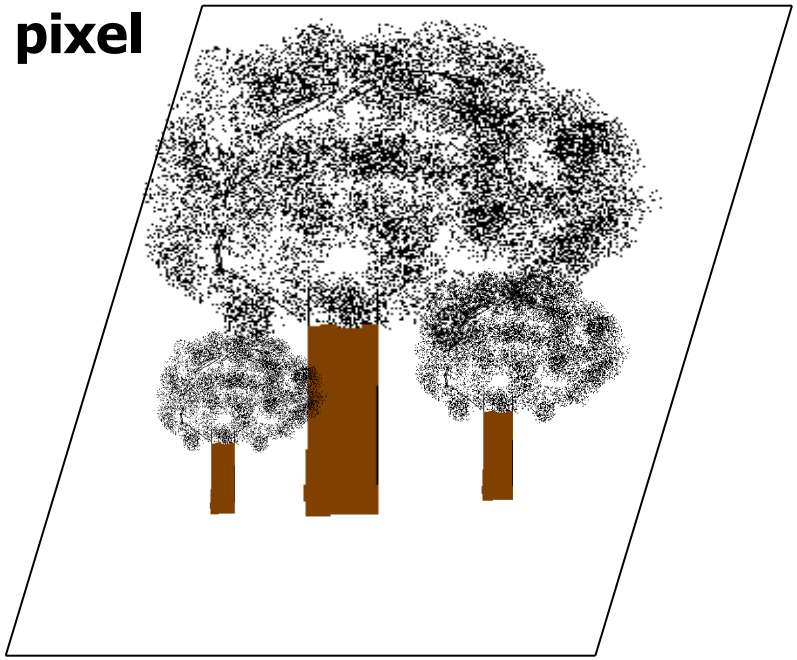
LSA SAF Land Surface Analysis

1 pixel



1 pixel



FVC=0.8 **LAI= 5**	**FVC=0.8** **LAI= 5**	**FVC=0.6** **LAI= 5**	**FVC=0.8** **LAI= 7**
a ..?	b ..?	c ..?	d ..?

LSA SAF Vegetation Products

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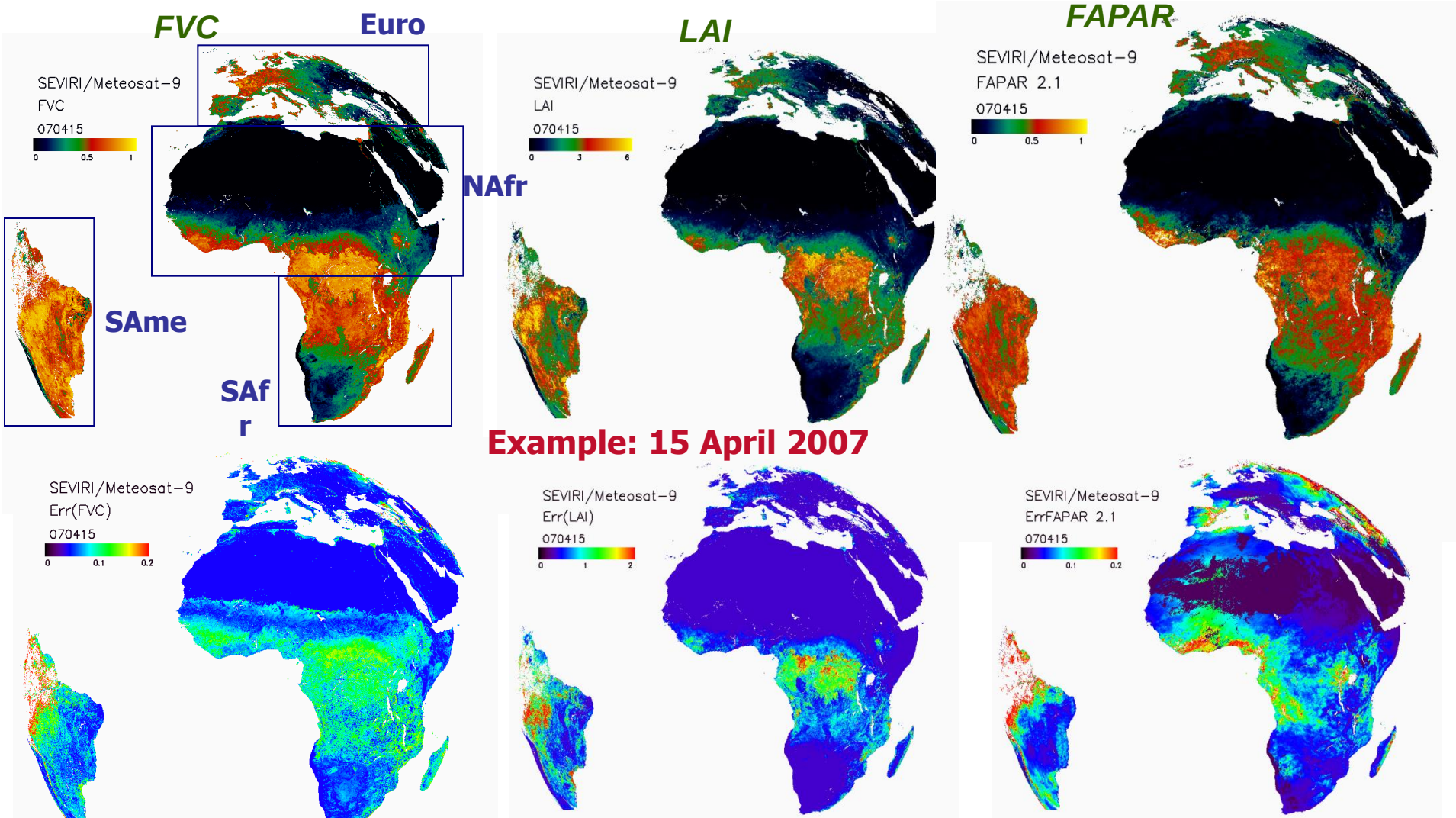
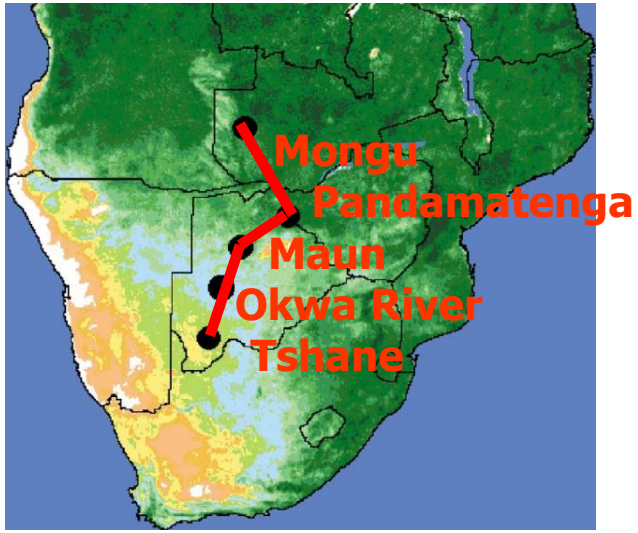
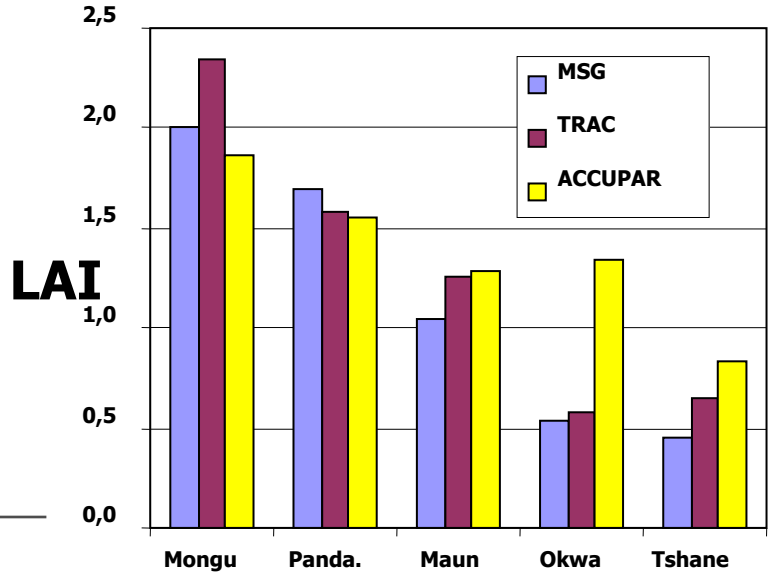
LSA SAF Land Surface Analysis

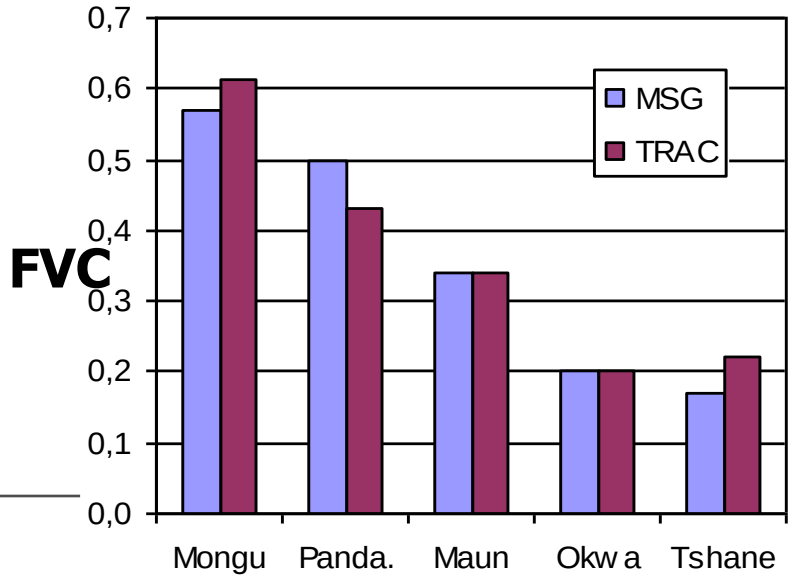


- **http://landsat.meteo.pt**
- **EUMETCAST**

Products Validation



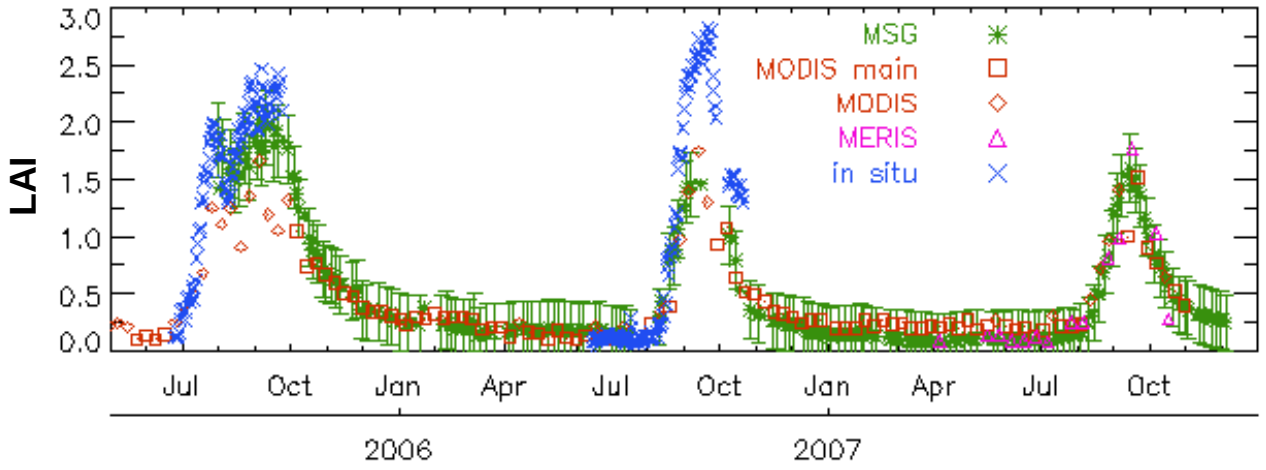




Products Validation

➢Comparison with in situ measurements

Dahra (Senegal)



MSG

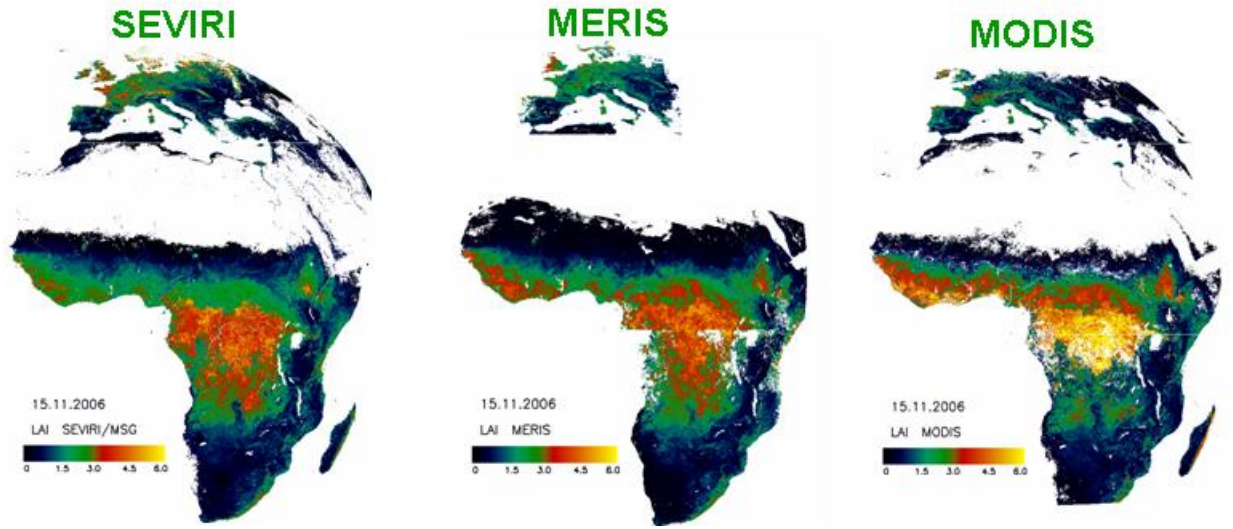
MODIS

MERIS

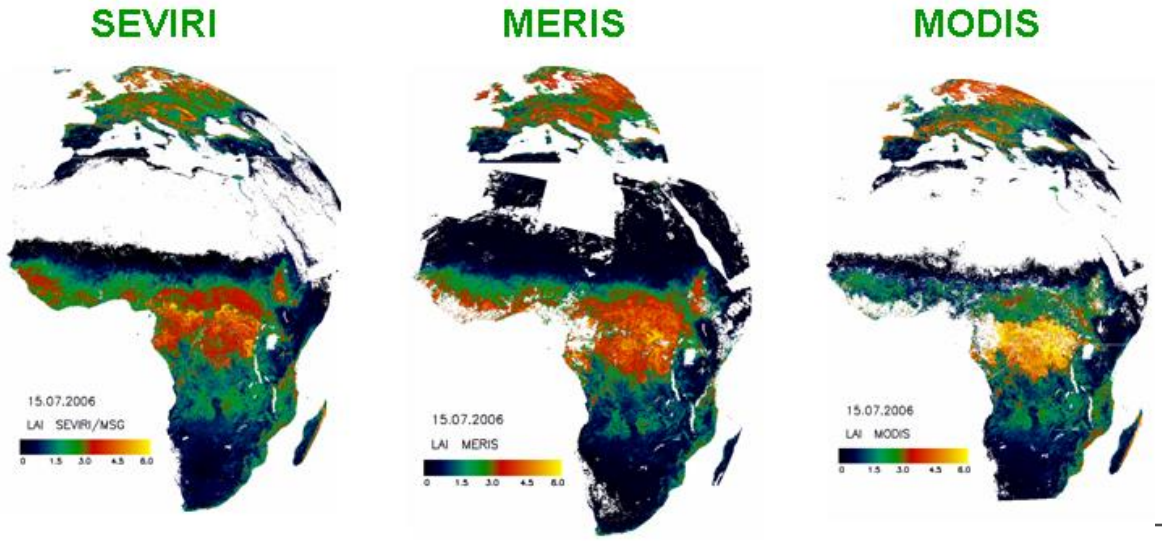
- All products are consistent with ground measurements;
- LSA SAF LAI better follows the seasonality of the vegetation activity during 2006 and 2007;
- The peak of the green season is well captured by LSA SAF LAI;

Products Validation

November 2006:



July 2006:



LAI

SEVIRI/ MERIS/ MODIS

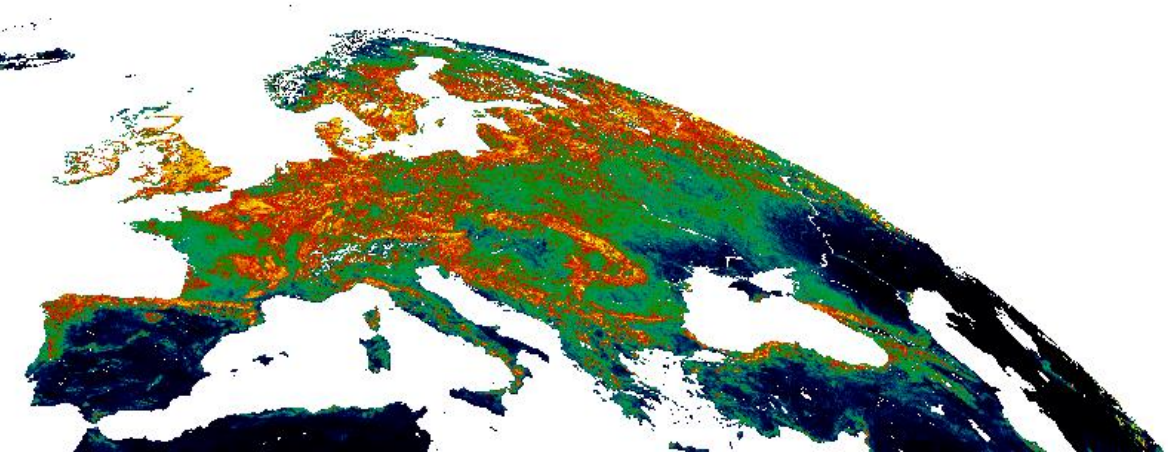
- High spatial consistency;
- LSA SAF LAI presents less gaps in vegetated areas.

LSA SAF team (F. Camacho, J. Garcia-Haro)

Quality monitoring

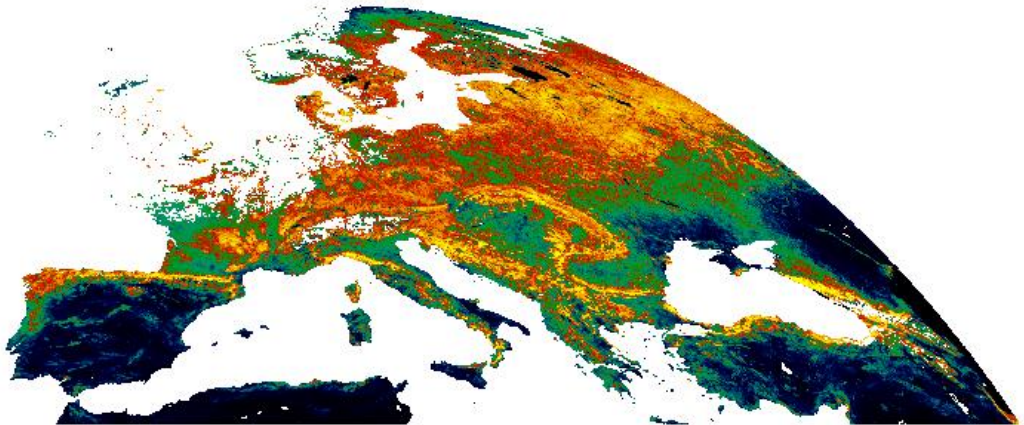
MSG VEGA PRODUCTS

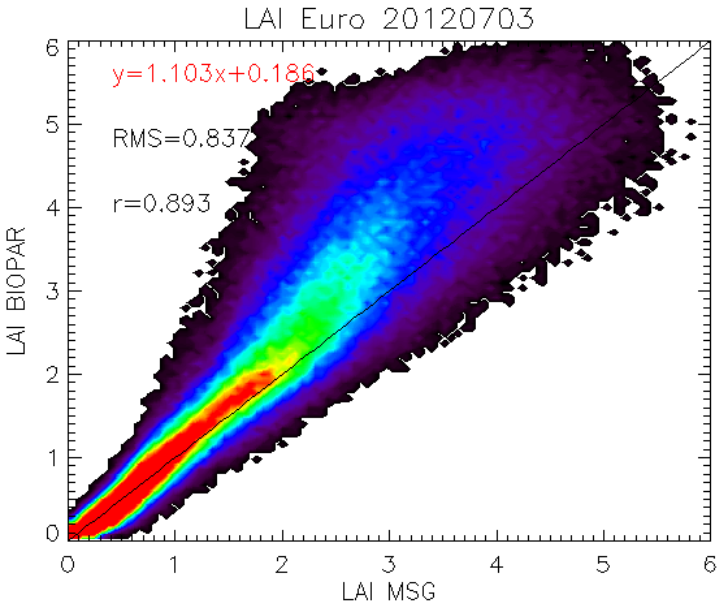
20120703



BIOPAR PRODUCTS

20120703

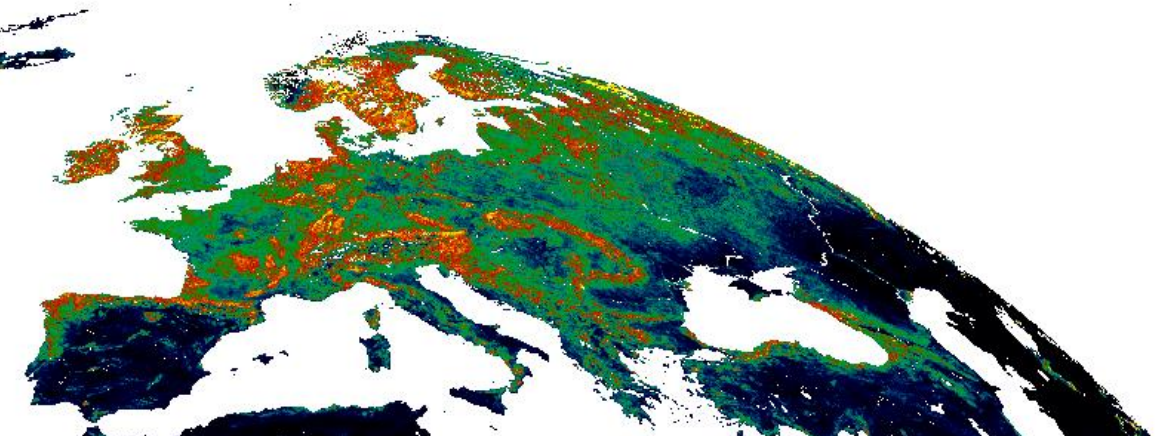




Quality monitoring

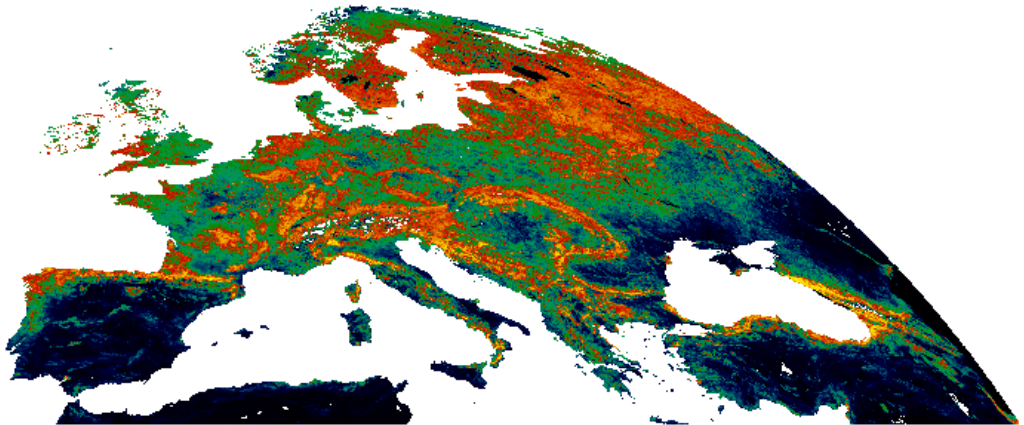
MSG VEGA PRODUCTS

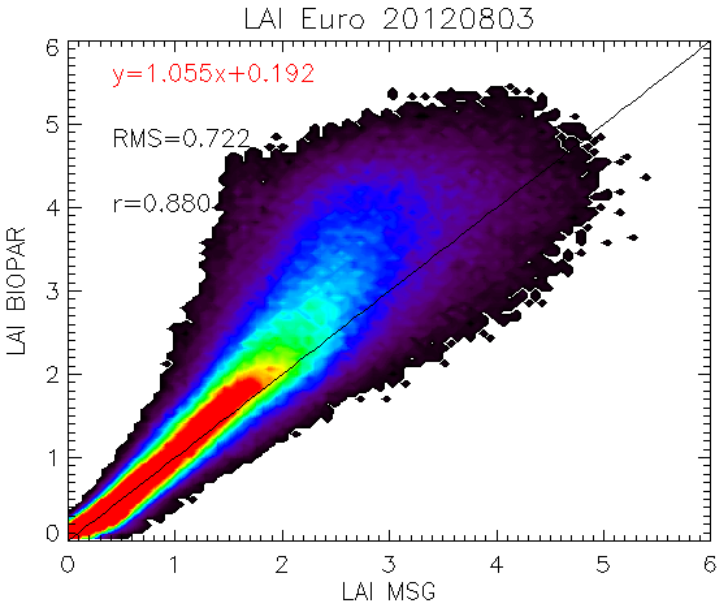
20120803



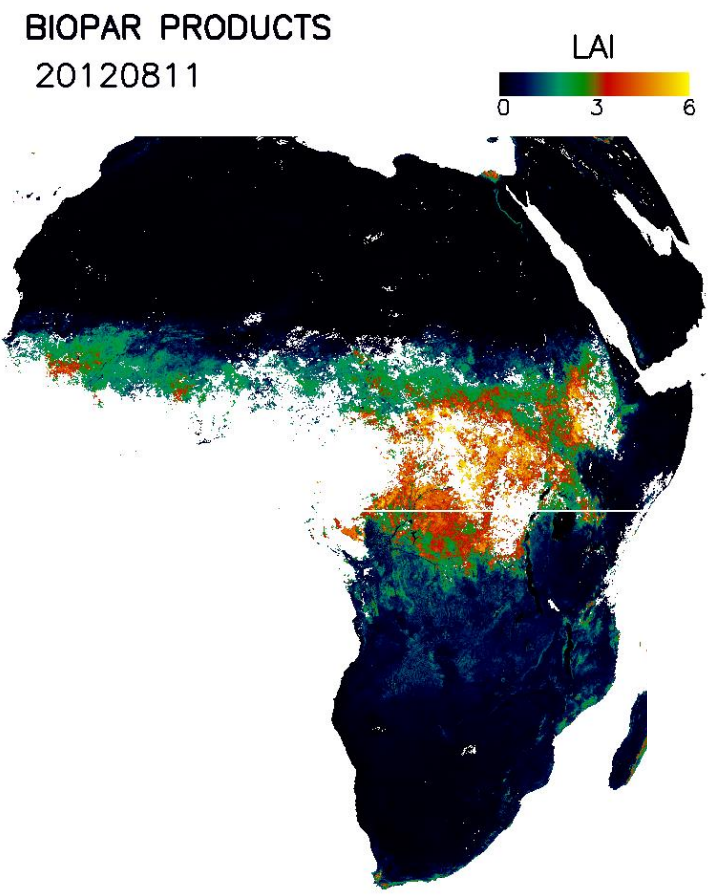
BIOPAR PRODUCTS

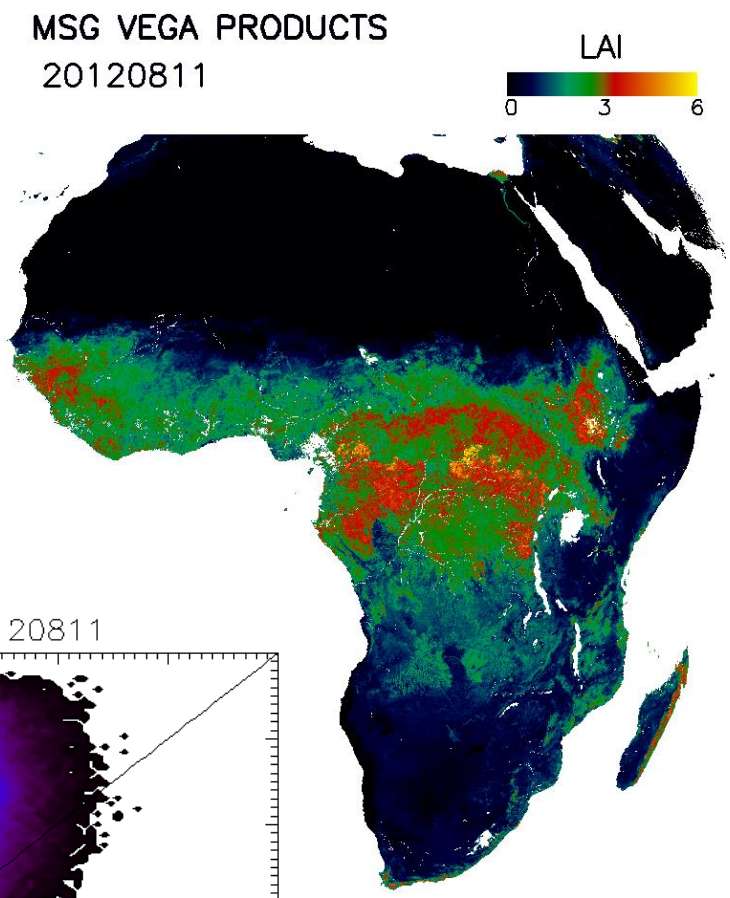
20120803

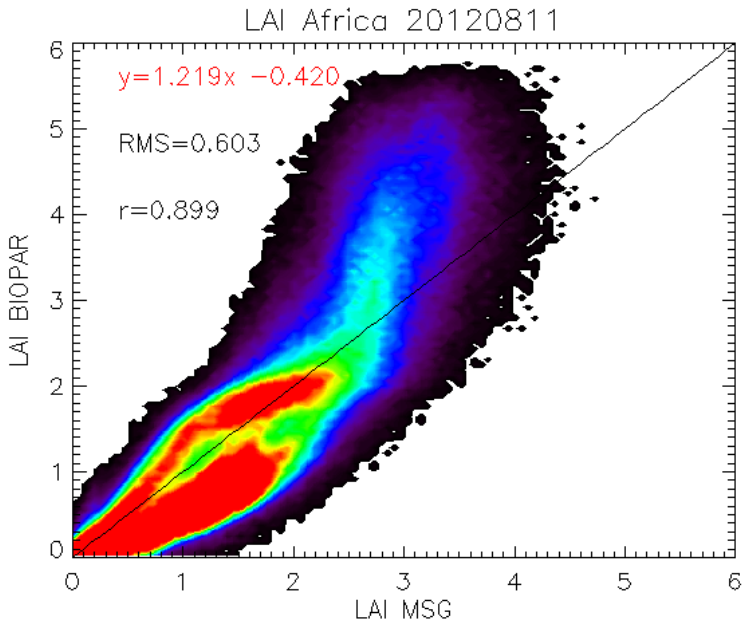




Quality monitoring







Overall quality of LSA SAF Vegetation Products

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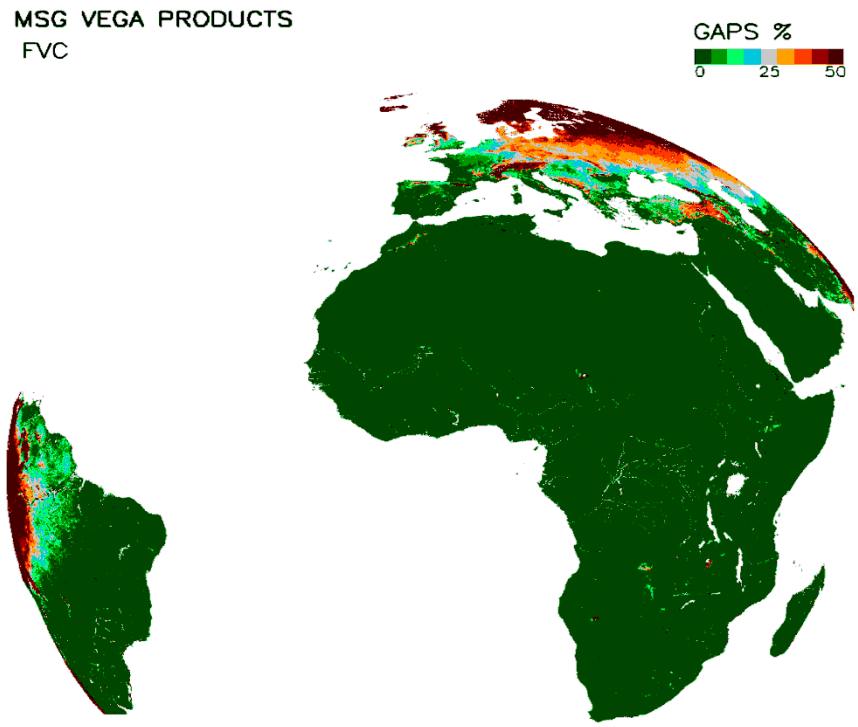
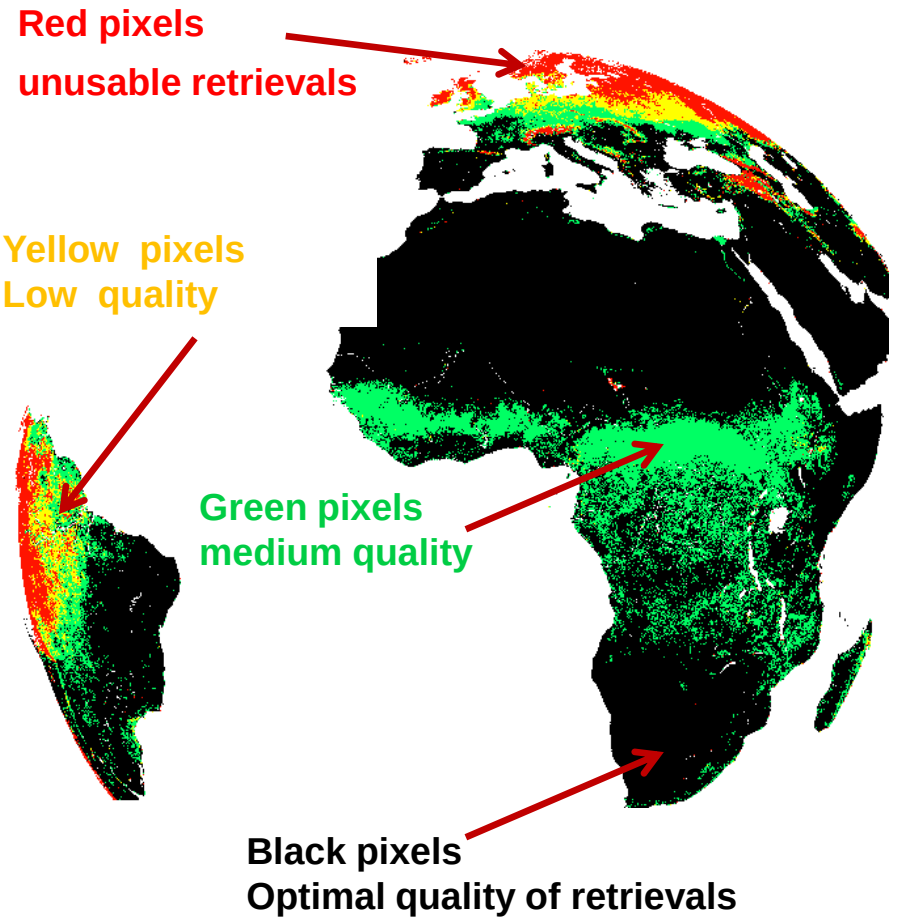
LSA SAF Land Surface Analysis

Percentage of gaps over 1 year of data



Mean value of the product error along year 2007



Potential Applications of LSA SAF vegetation products

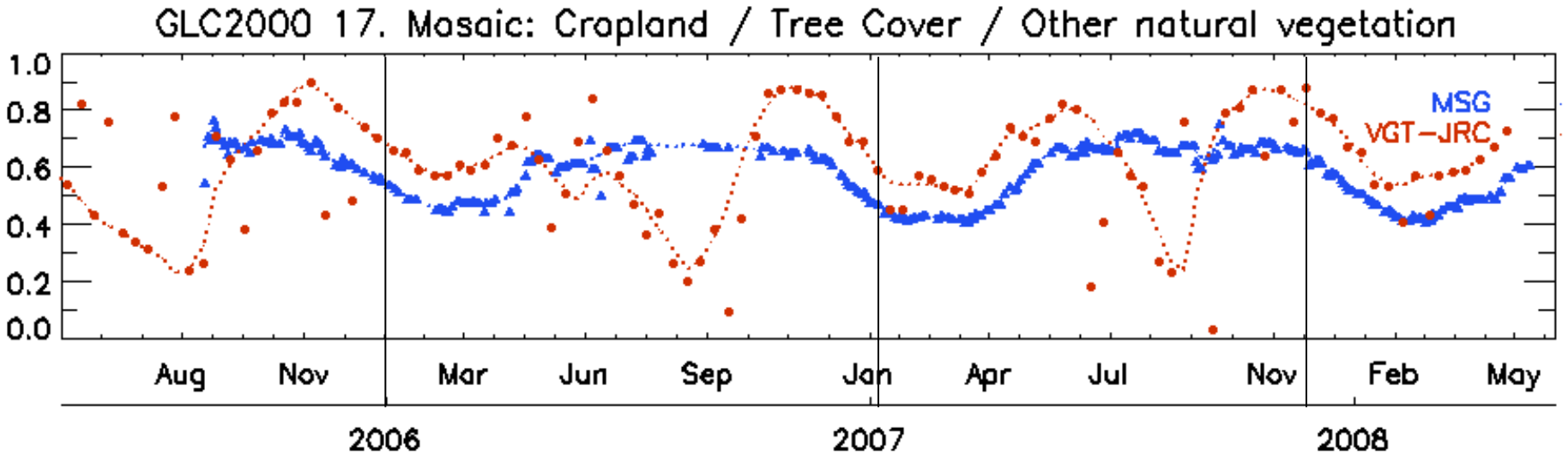
- ✓ Detect the start, length & amplitude of the growing season
- ✓ Follow the timing of phenological stages (onset of greenness, maximum development, senescence);
- ✓ Monitor Vegetation response to climatic variability
- ✓ Monitoring of vegetation disturbances (droughts, fire, retrospectively analyse the impact of vegetation disturbances)

Potential Applications

➢ Reconstruction of seasonal curves

The date of start of the growing season(SOS) is a critical parameter for food security monitoring.

C.Afr – Guinea Gulf



- FVC product from VEGETATION (VGT – JRC)
- FVC product from SEVIRI (LSA SAF)

indicate the SOS in 2007 !!!

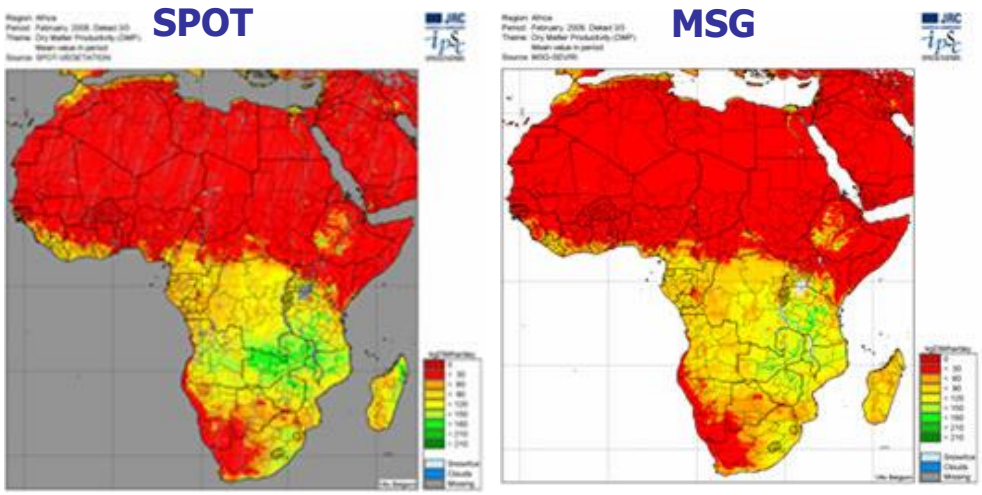
Potential Applications

The EUMETSAT Network of Satellite Application Facilities

LSA SAF Land Surface Analysis

➢ Estimation of Dry Matter Productivity (DMP)

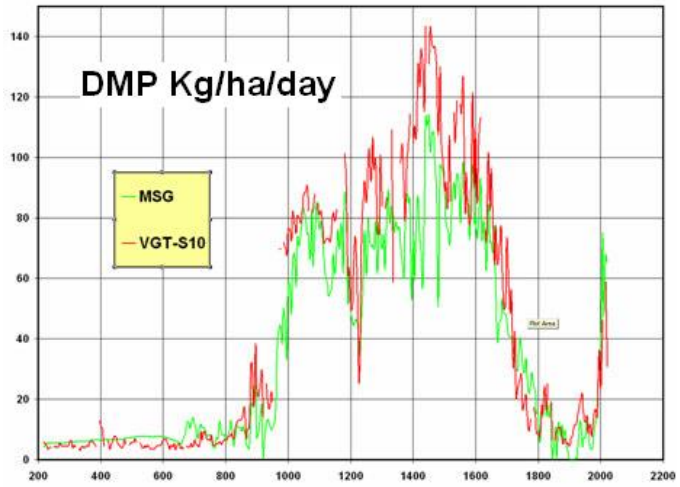
DMP represents the increase in dry matter biomass.



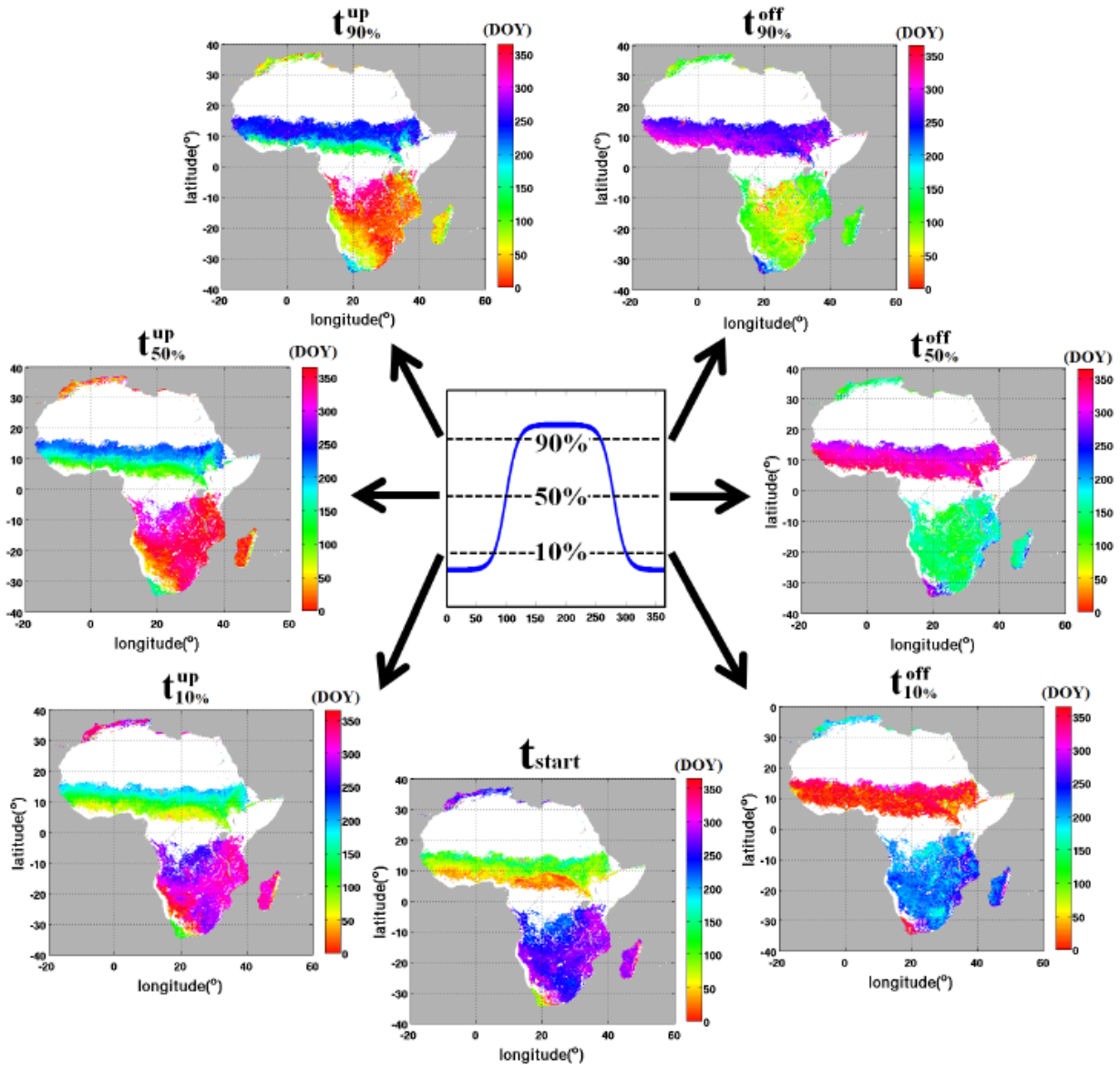
2008, February, Dekad 3 over Africa

➢Good spatial consistency

A North-South transect through Africa (from Lybia to Cape Town) also highlights the good correspondence between SPOT and MSG:



Potential Applications



➢Mean phenological dates of reaching 10%, 50% and 90% of LAI range during green-up and green-off periods

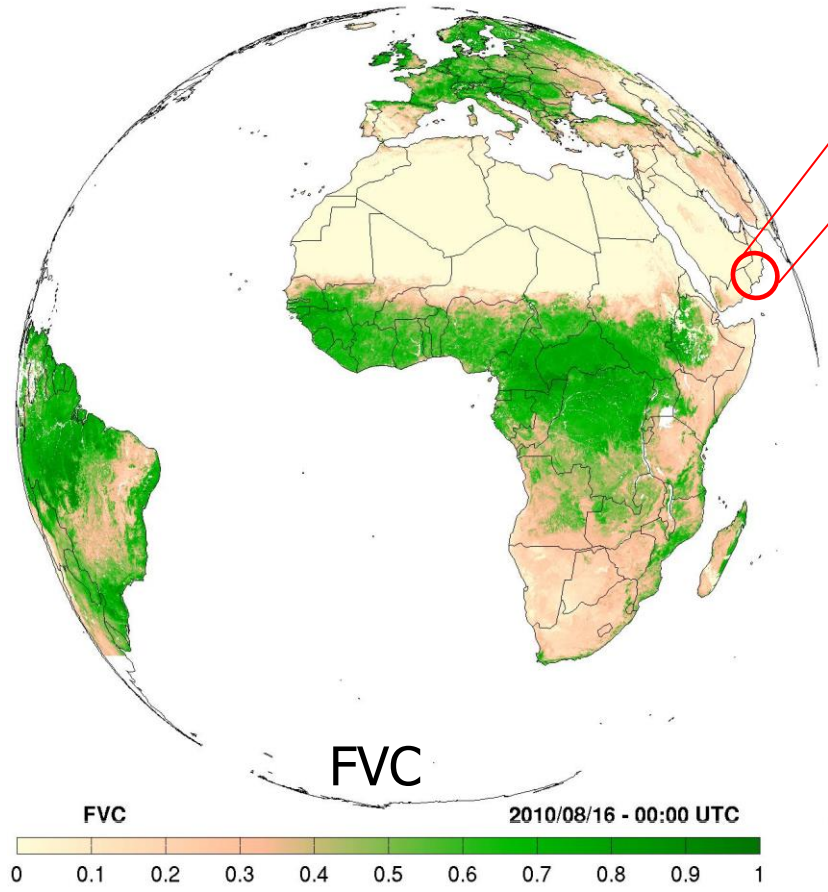
Guan, K., E. F. Wood, D. Medvigy, K. K. Caylor, S. Li and S. J. Jeong, 2012, Derive vegetation phenological time and structure information over Africa using SEVIRI daily LAI, *IEEE transactions on Geoscience and Remote Sensing*, in press.

Applications – Veg Monitoring

The EUMETSAT Network of Satellite Application Facilities

LSA SAF Land Surface Analysis

➢Effects of the khareef on vegetation

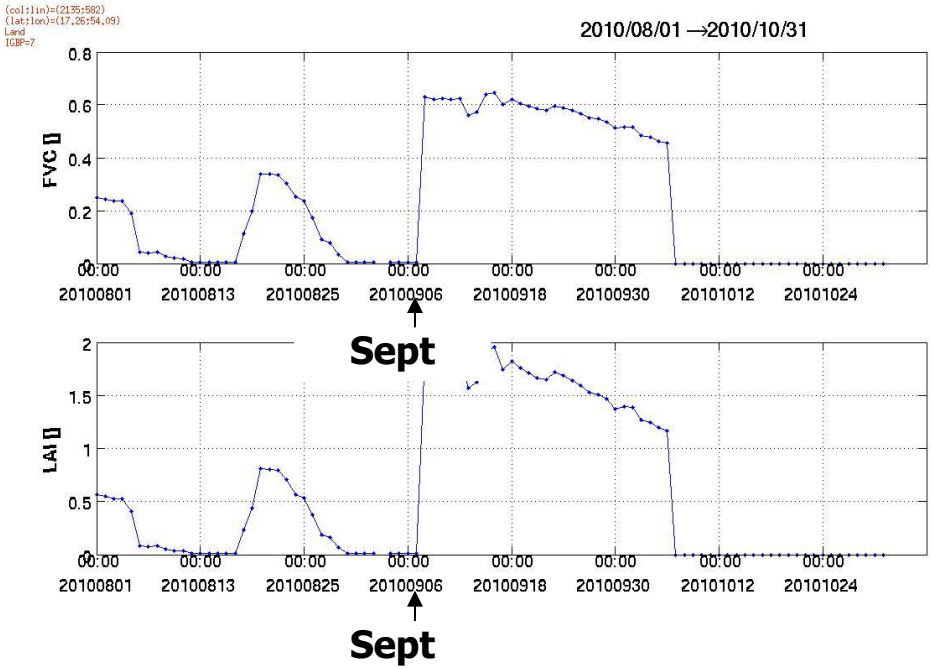


15 Aug 2010

15 Sep 2010

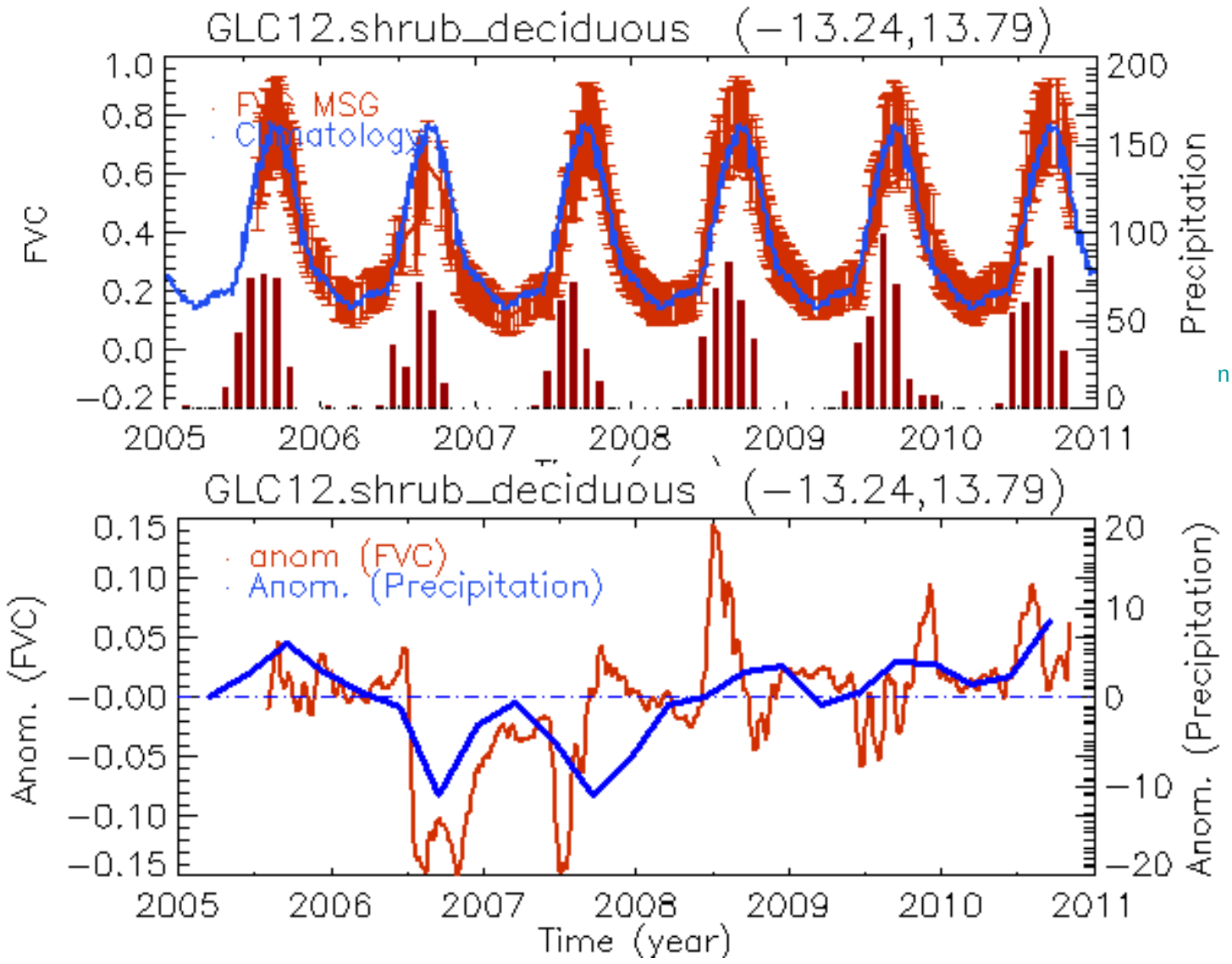
15 Oct 2010

The south east monsoon affects the Dhofar region from about June to early September.



Applications – Veg Monitoring

Vegetation response to climatic variability



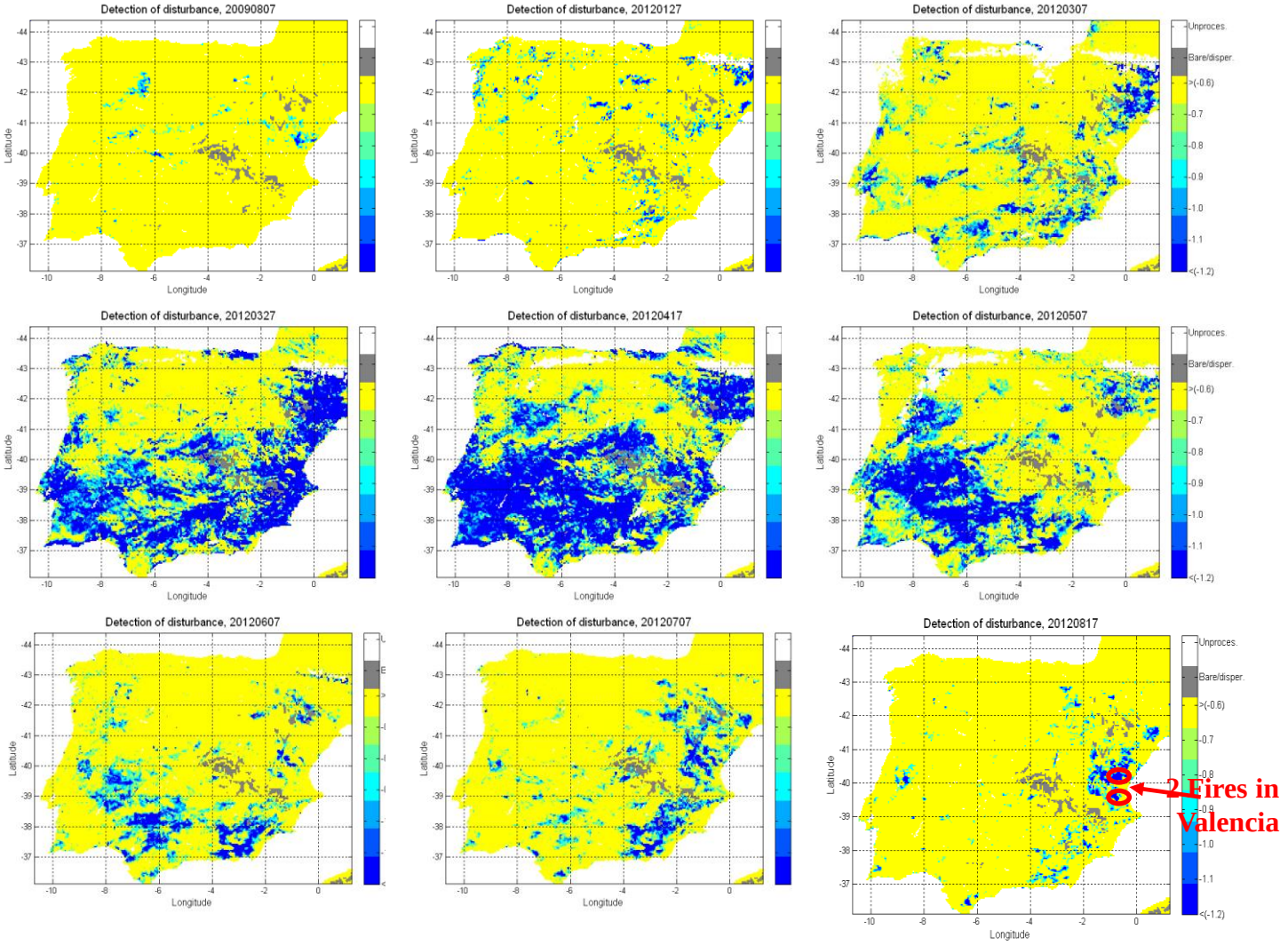
Climatologies based on timeseries of FVC (SEVIRI/MSG)

Applications – Veg Monitoring

The EUMETSAT Network of Satellite Application Facilities

LSA SAF Land Surface Analysis

Drought monitoring in the Iberian peninsula

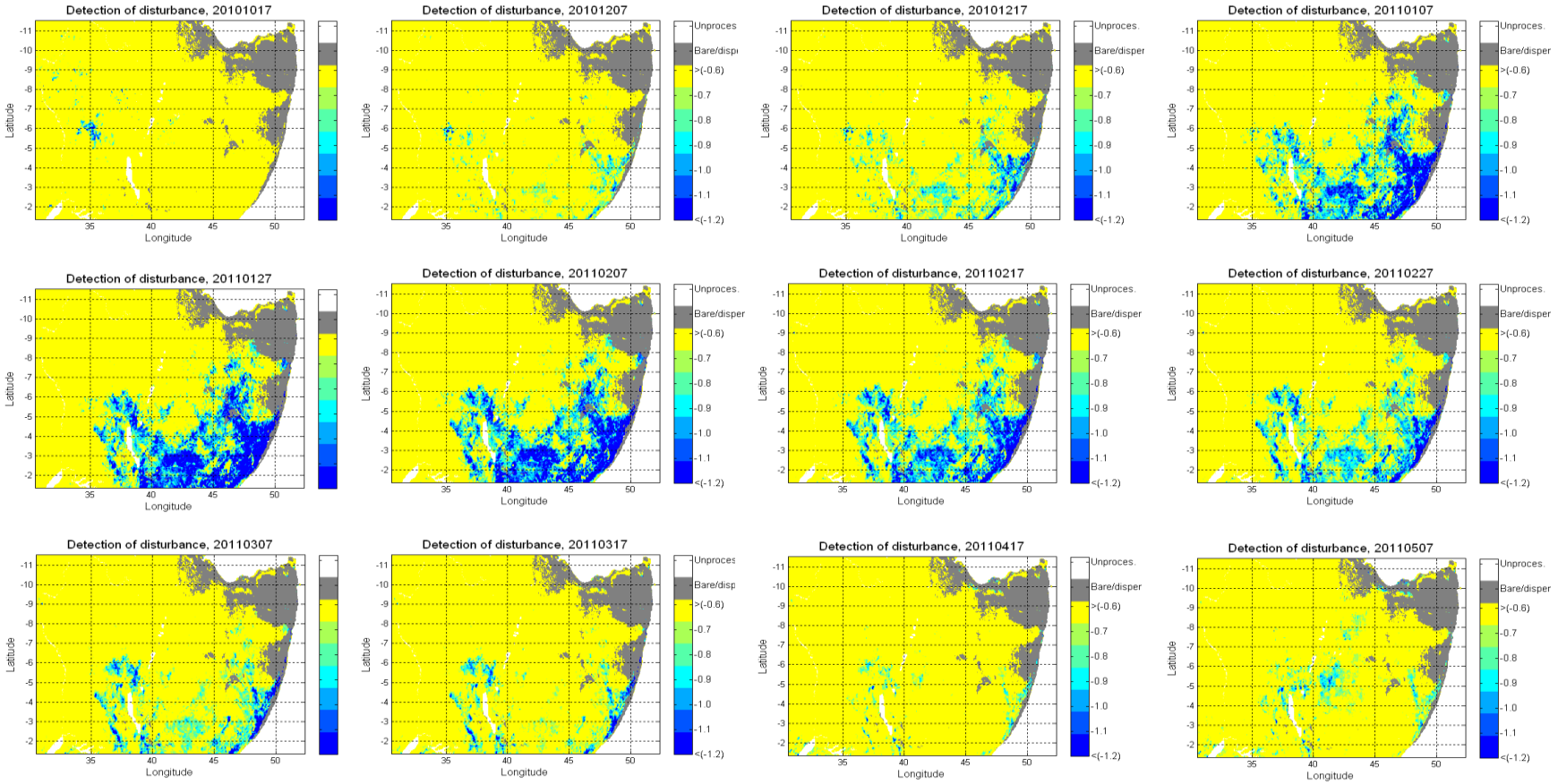


Applications – Veg Monitoring

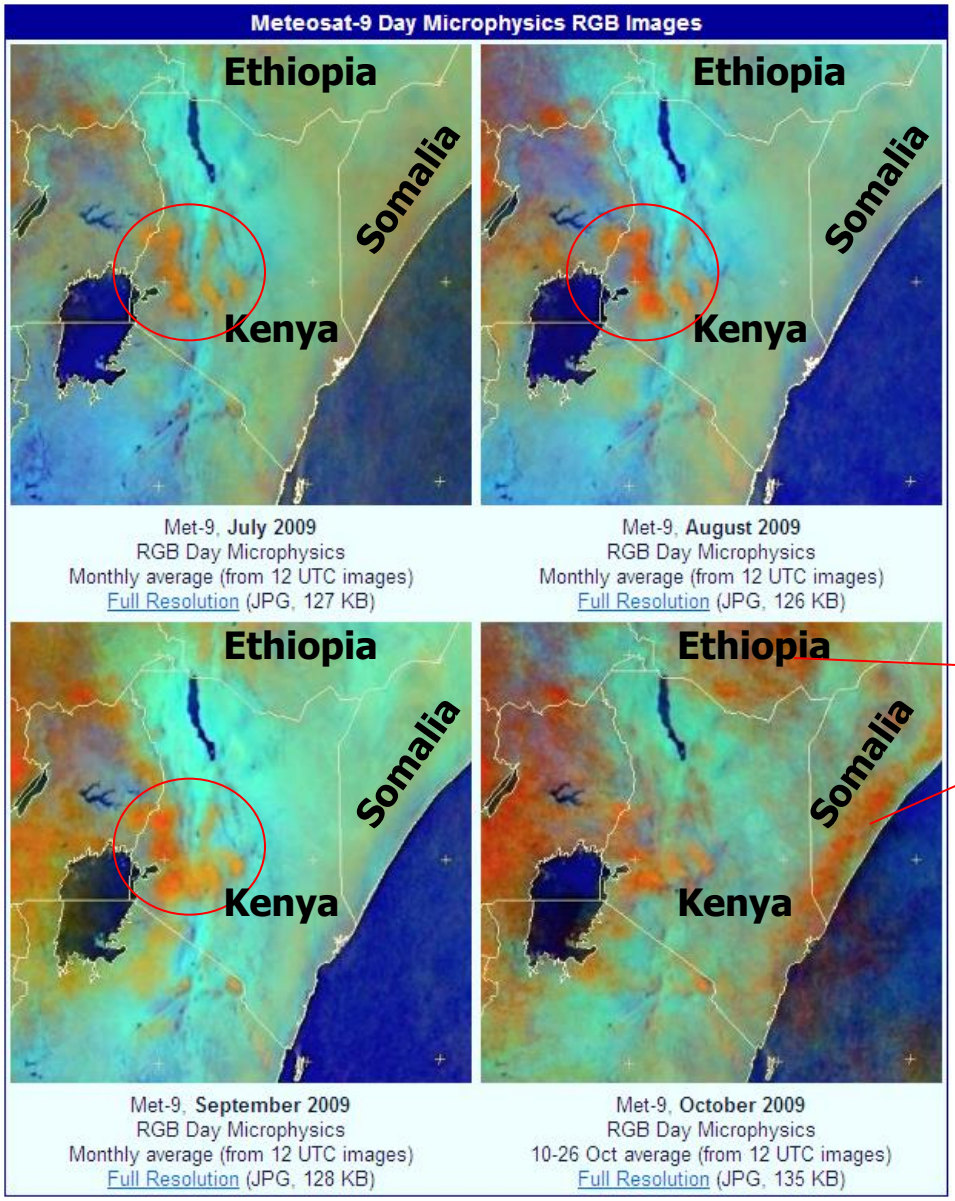
The EUMETSAT Network of Satellite Application Facilities

LSA SAF Land Surface Analysis

Drought monitoring Horn of Africa (2011)



Applications – Drought Monitoring



Severe Drought in Kenya 2009

Blue colors – cloud free/no rain areas

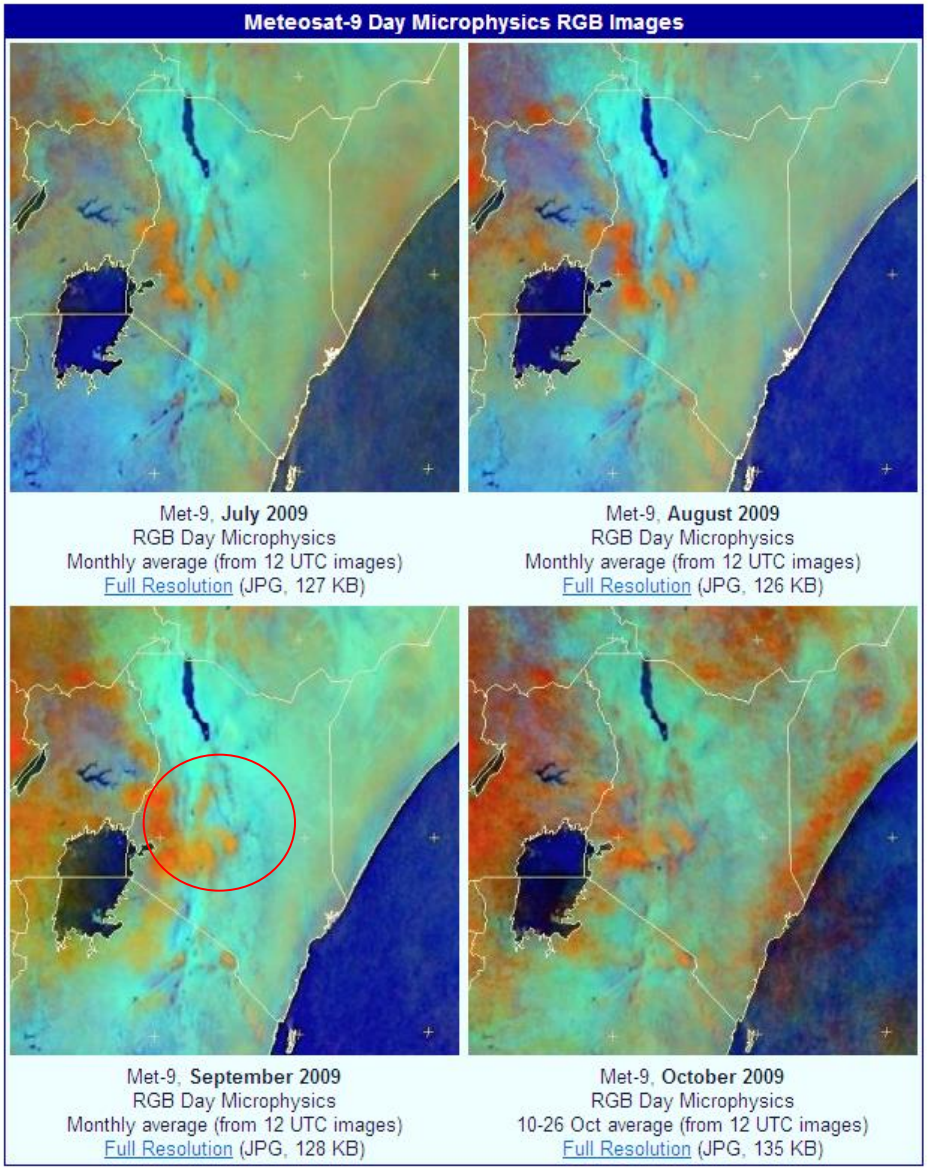
Red colors – high coverage of cold ice clouds & precipitation

October

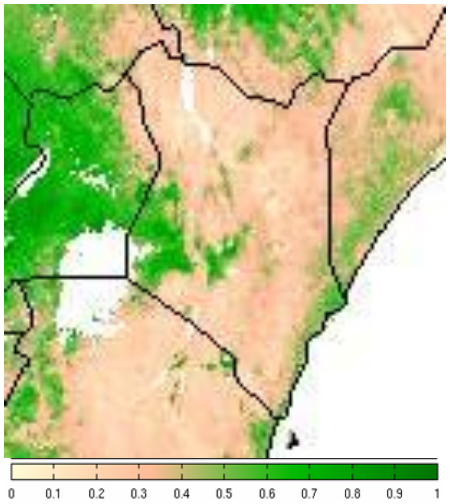
clouds and rains developed also in Somalia, Ethiopia and the coastal/central areas of Kenya.

Sequence of images from http://oiswww.eumetsat.org/WEBOPS/iotm/iotm/20091001_drought/20091001_drought.html

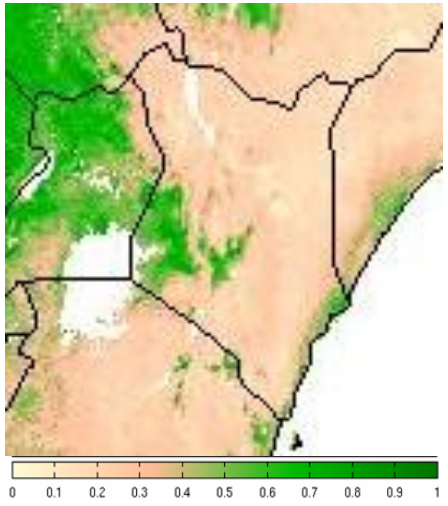
Applications – Drought Monitoring



Which from bellow is from November 2009?



LSA SAF FVC



LSA SAF FVC

LSA SAF Vegetation Products

More information and data download at:

http://landsaf.meteo.pt