The EUMETSAT Network of Satellite Application Facilities

LSA SAF
Land Surface Analysis

Capability of SEVIRI/MSG for large-scale monitoring of vegetation condition

J. García-Haro, F. Camacho, A. Verger, J. Meliá

VNIVERSITAT DE VALÈNCIA

EOLAB
Earth Observation Laboratory
Spin-off Universitat de València

Outlines

1. **Introduction**

   product description, algorithm principles, input data

2. **Scientific validation and expert knowledge**

   known limitations and added-values

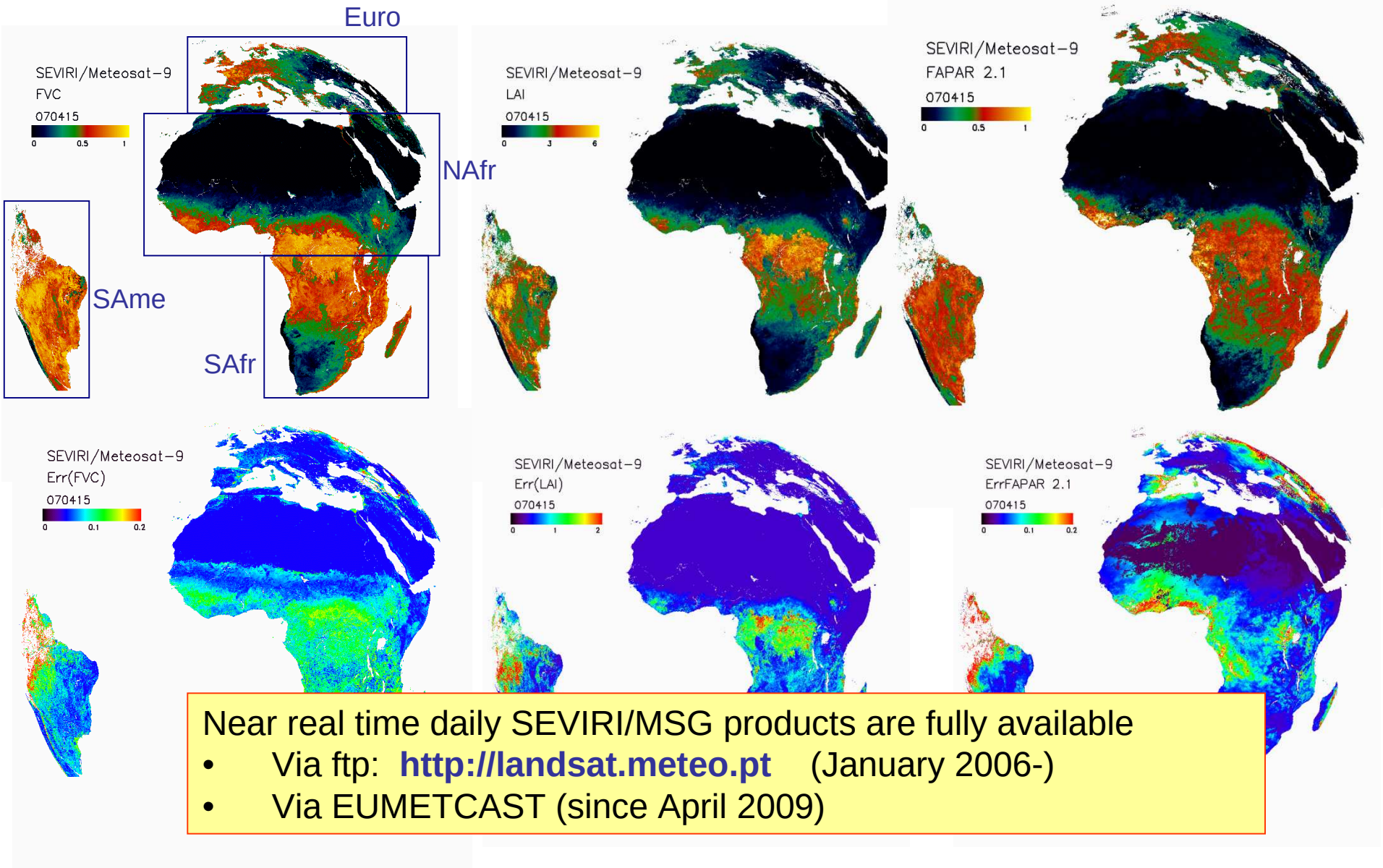
3. **Potential applications**

Product content

Introduction

Example: 15 April 2007

FVC ***LAI*** ***FAPAR***



Near real time daily SEVIRI/MSG products are fully available

- Via ftp: **http://landsat.meteo.pt** (January 2006-)
- Via EUMETCAST (since April 2009)

Algorithms description

- **Fraction of ‘ green’ Vegetation Cover (FVC)**

⇒ Probabilistic Spectral Mixture Analysis

- 2 components (veg,soil): $R = R_v f_v + R_s f_s$
- Each component: mixture of gaussians

$$\sum_{k=1}^{G_j} \tau_k \phi_k (\mu_{jk}, \Sigma_{jk})$$

$$p(M_K \mid r_j) = \frac{p(r_j \mid M_K)\pi(M_K)}{\sum_{i=1}^{N} p(r_j \mid M_i)\pi(M_i)}$$

- **‘True’ Leaf Area Index (LAI)**

Pragmatic approach based on a modified Beer’s law: $$LAI = \frac{-1}{b \cdot G(\theta_s = 0) \cdot \Omega} \cdot \frac{\ln(a_0 - FVC)}{a_0}$$

b=0.97, G=0.5, clumping (Ω) from a GLC-2000 lookup table.

- **’Daily’ Fraction of Absorbed PAR (FAPAR)**

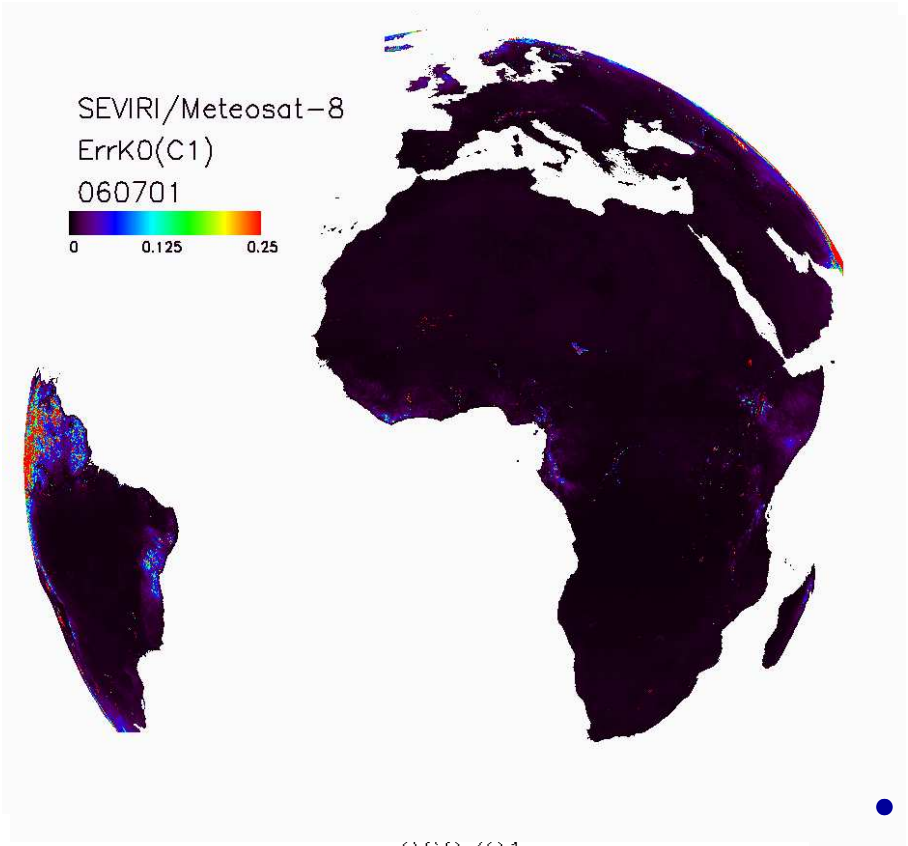
Statistical relationship between a vegetation index (RDVI) in an optimal geometry and daily integrated FAPAR (Roujean and Breon method).

$$RDVI = (NDVI \cdot DVI)^{1/2} = \frac{NIR - R}{\sqrt{NIR + R}}$$

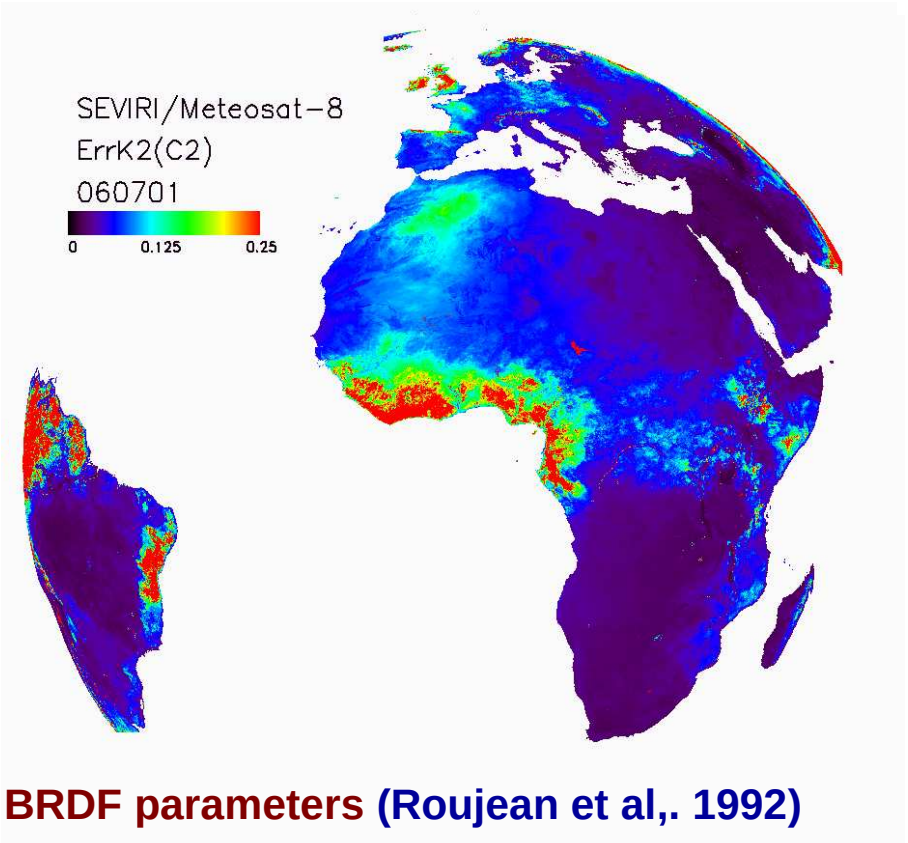
FAPAR=1.81*(RDVI)opt - 0.21

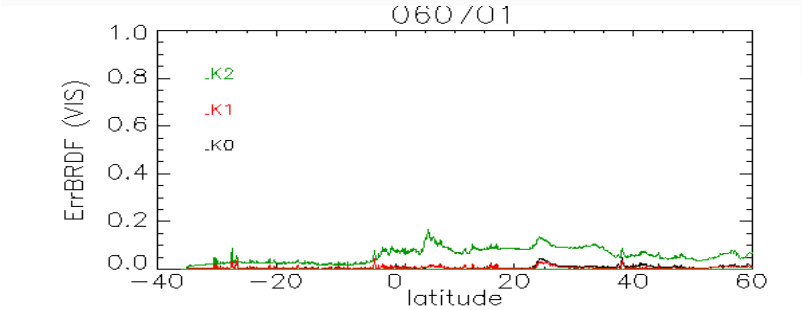
Sources of uncertainty: input errors

Error k0



Error k2

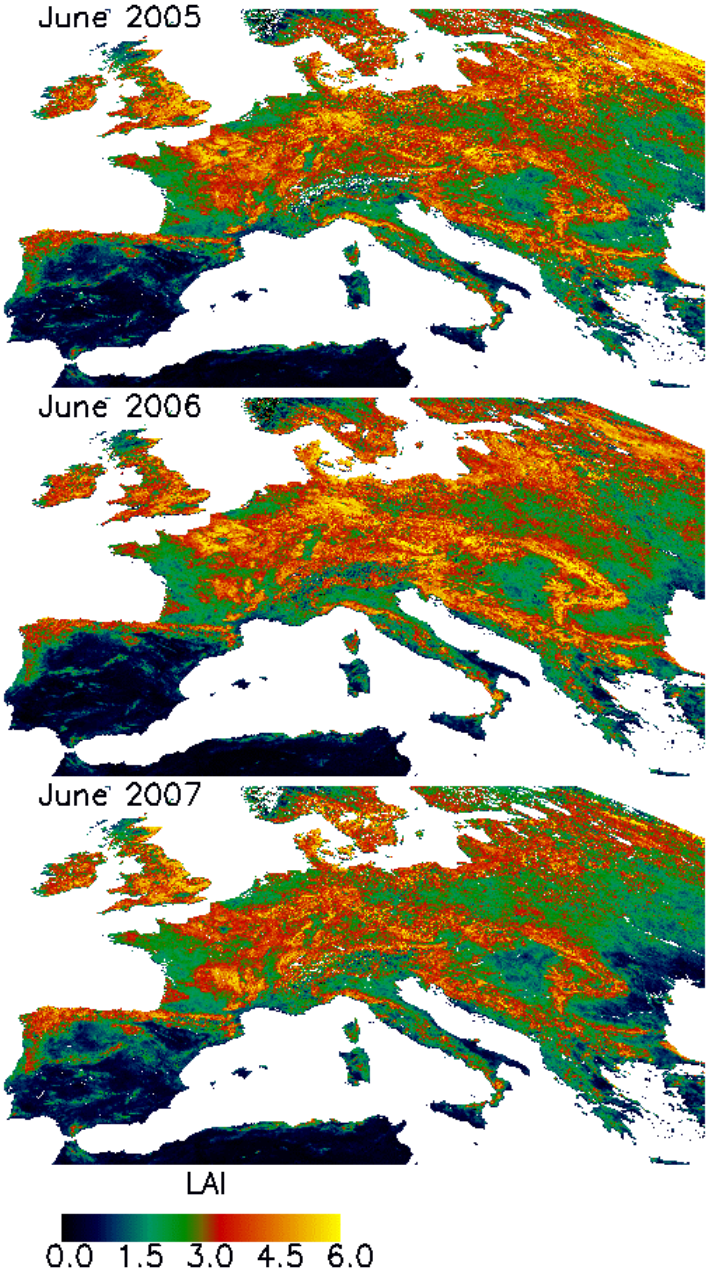


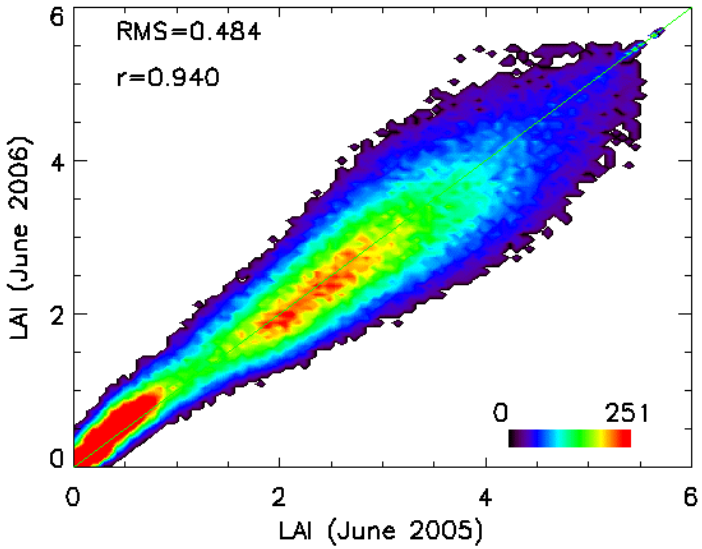


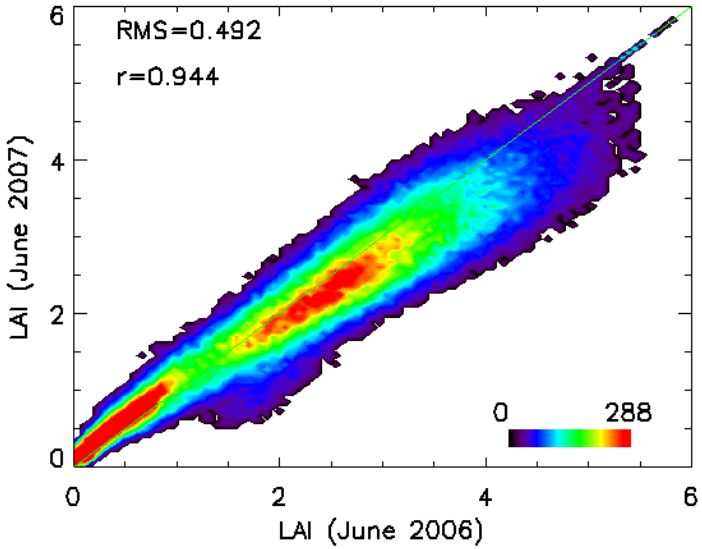
- **BRDF parameters (Roujean et al,. 1992)**
  k0 (RED, NIR, SWIR) for FVC → LAI
  k0,k1,k2 (RED,NIR) for FAPAR

VEGA_v2.1 products NOT COMPUTED if Errk0>0.05 or Errk2>0.2
For previous versions users have to discard pixels with large errors (see VEGA_PUM)

Products analysis: spatial consistency







Scientific validation of products

- **Algorithms were validated against other operational algorithms (JRC-Sahel (FVC), CYCLOPES (FVC, LAI, FAPAR), GLOBCARBON (LAI) over VEGETATION CYCLOPES and MODIS reflectance. A similar performance (even better) than the other methods is achieved. No improvements in quality was found using RT models.**

- **LSA SAF products were compared with CYCLOPES, POLDER, MERIS (TOAVEG & MGVI), JRC-SAHEL, SEAWIFS, VGT4Africa and MODIS over Europe and Africa and available ground truth (VALERI, SAFARI)**

Important inconsistencies are found between the existing products (relative differences up to 100%) but not in terms of temporal variations.

LSA SAF VEGA (daily products):
Fit well with the existing satellite and ground thruth within the err or bars

- **FVC: 0.10-0.15**
- **LAI: 0.5-1.0**
- **FAPAR: 0.10-0.15 (MSG), 0.20 (other products)**

- Clean profiles adequate for monitoring the vegetation dynamics
- Africa is a consolidated region: no gaps, realistic temporal profiles

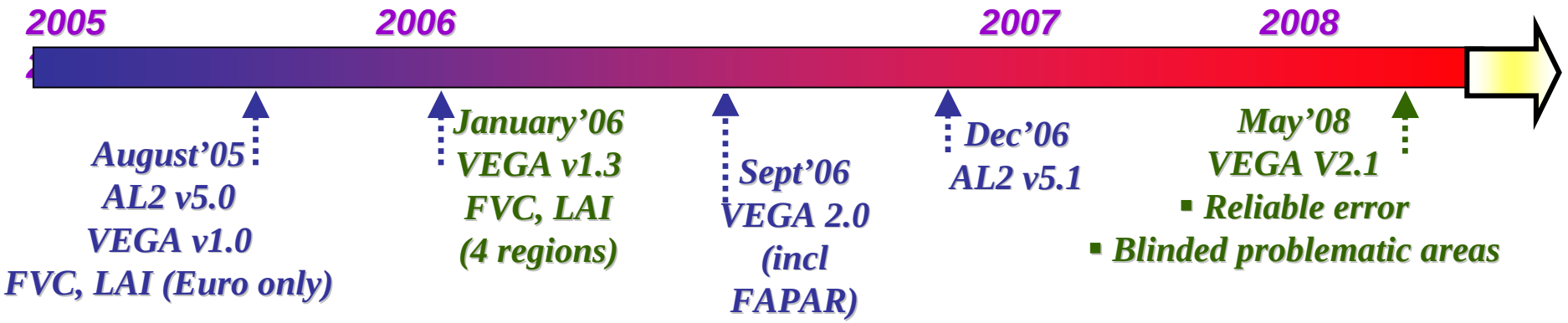
Known limitations

Expert knowledge

- Usability of VEGA products is only limited for high view zenith angles, not in AFRICA
- FVC, LAI are land cover dependent (GLC-2000), which may introduce some spatial artefact
- Take care about a possible over-estimation of FVC for low values (semi-arid areas).
- FAPAR temporal profiles present some noise introduced for the k2 parameter.

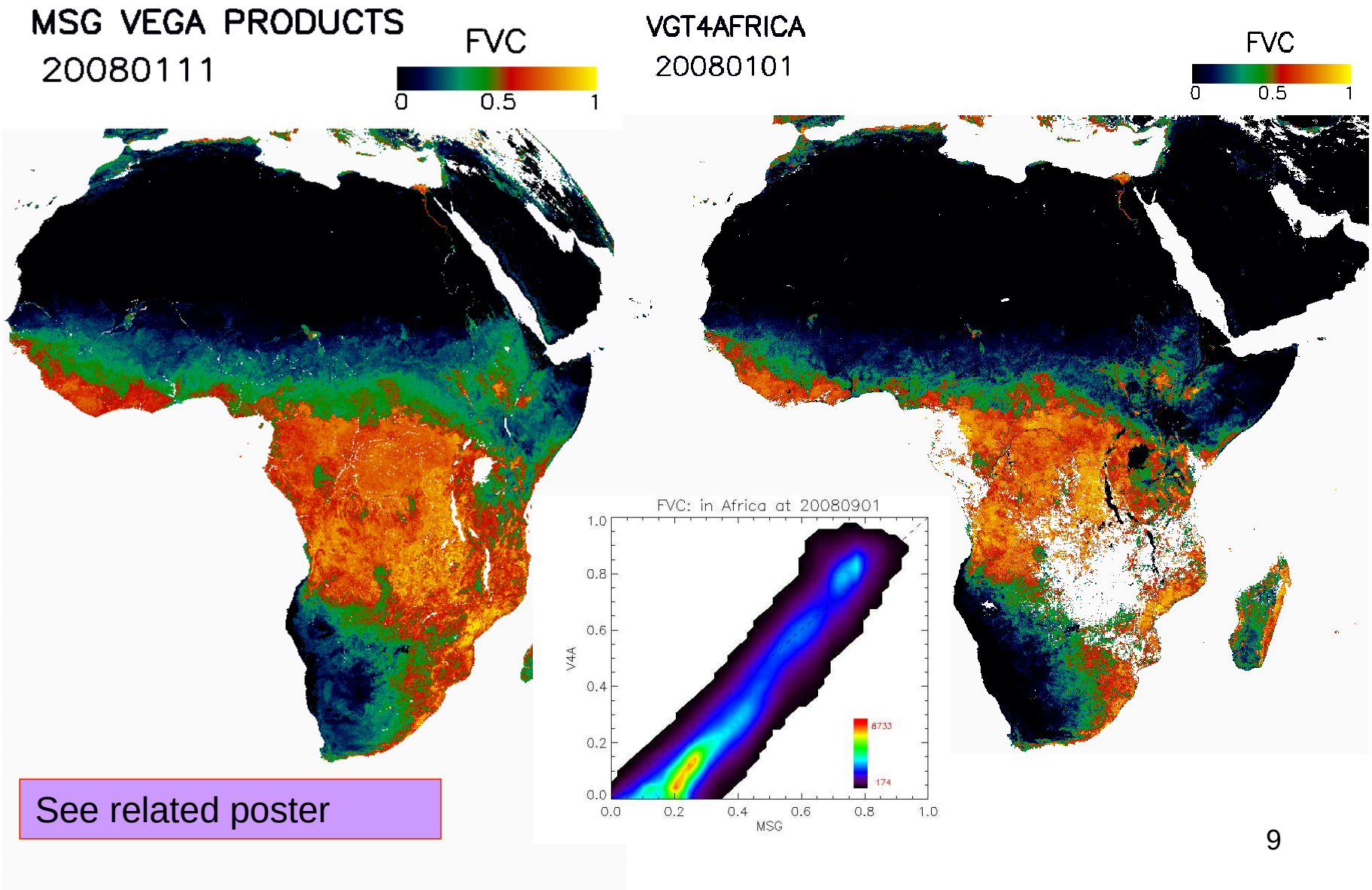
TIME SERIES:

- Changes in the algorithm could introduce changes in products– **No back-processing (so far)**
- Missing dates (~15%) due to system stops



Indirect validation

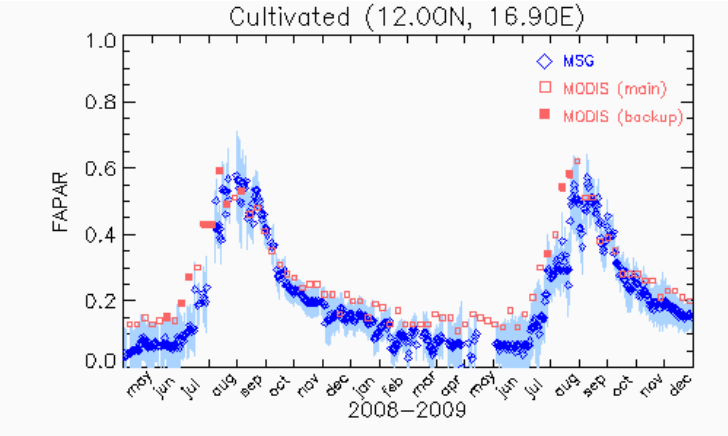
Comparison with VGT4SAFRICA FVC

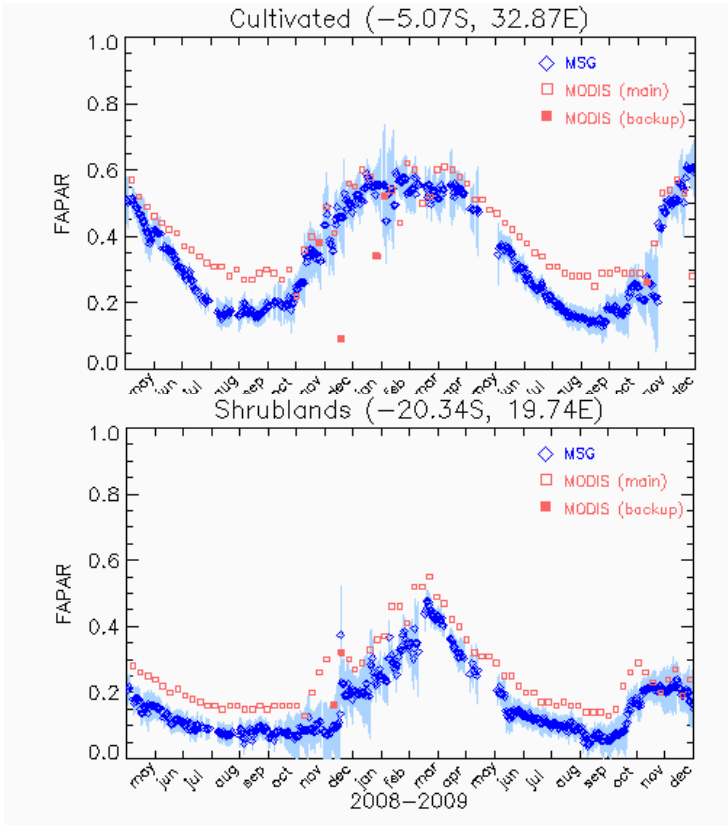


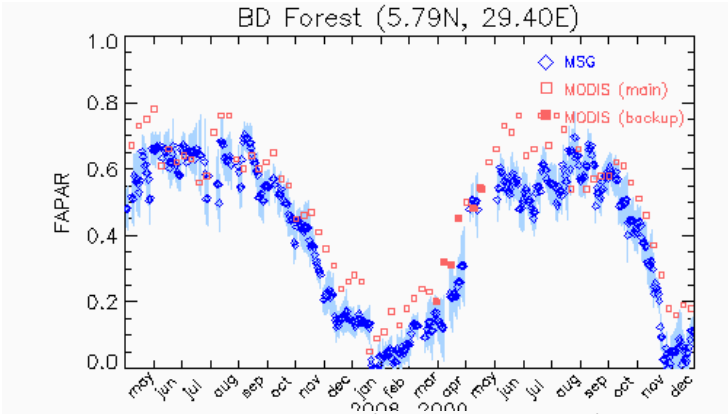
See related poster

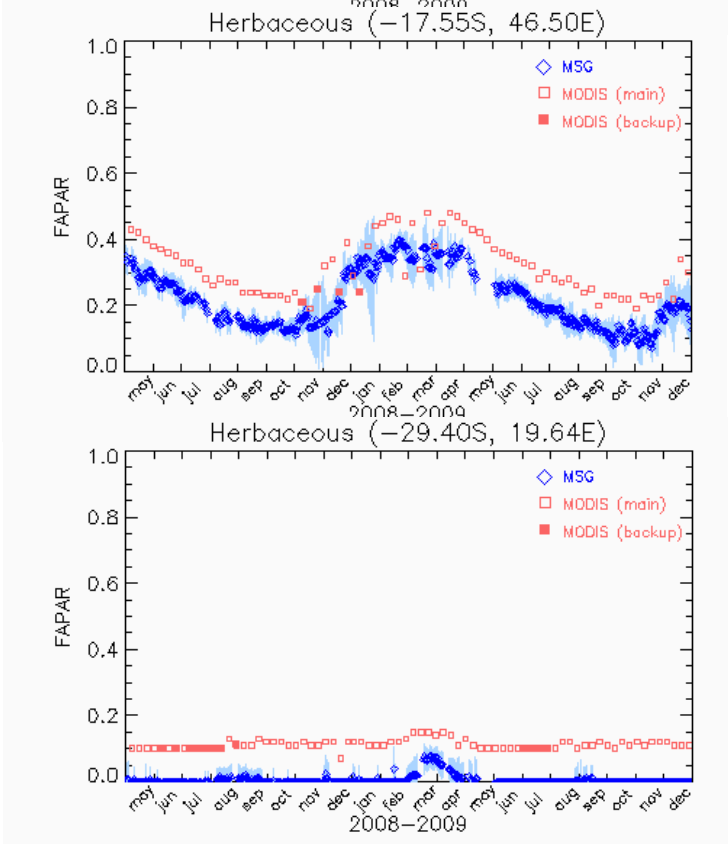
Comparison with other equivalent products

MODIS FAPAR Euro/Africa

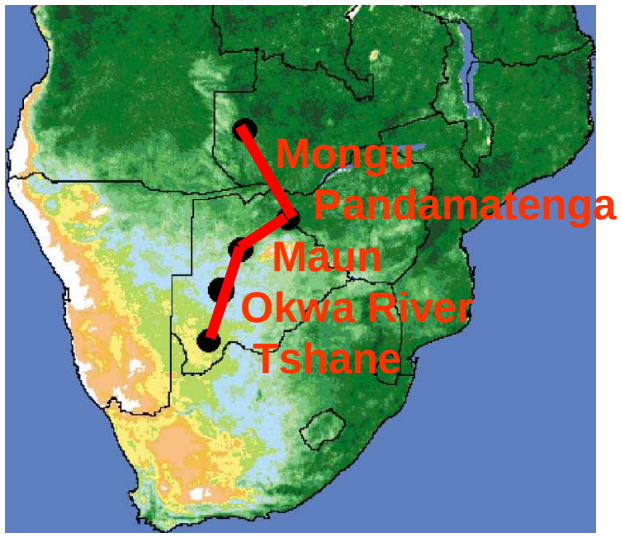


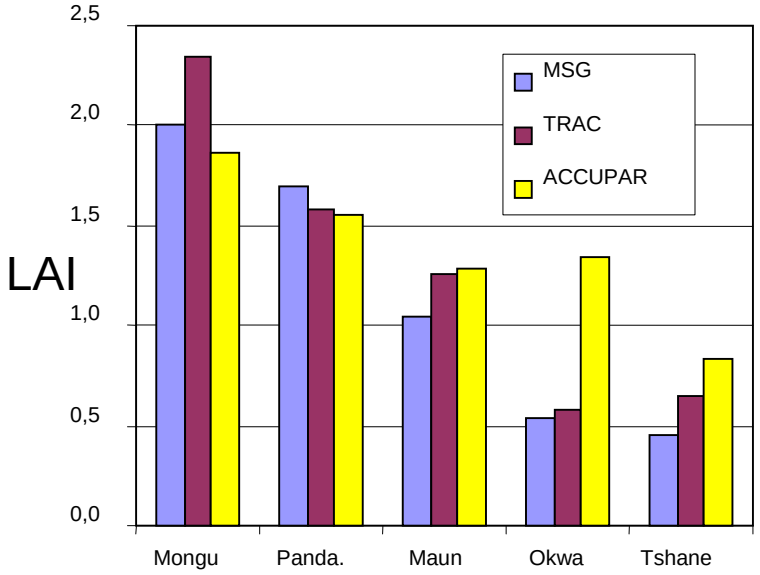


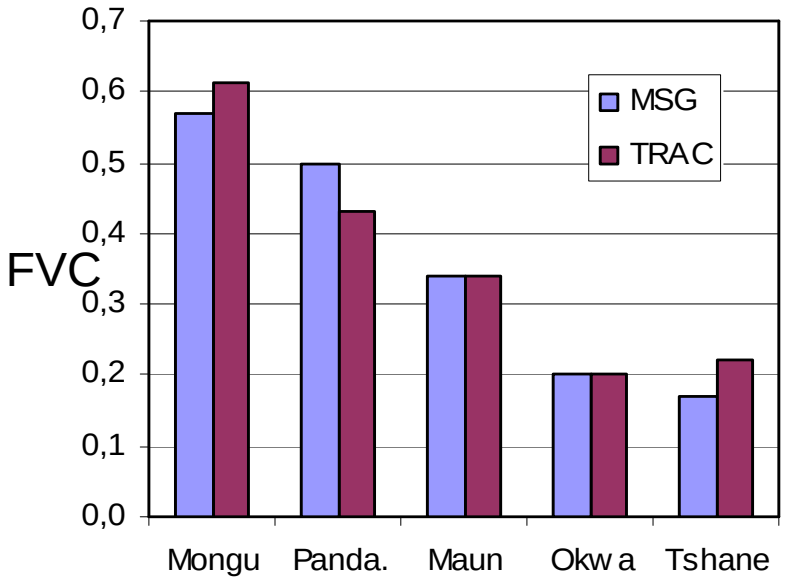




Vegetation productivity along the Kalahari transect FVC/LAI SAfr

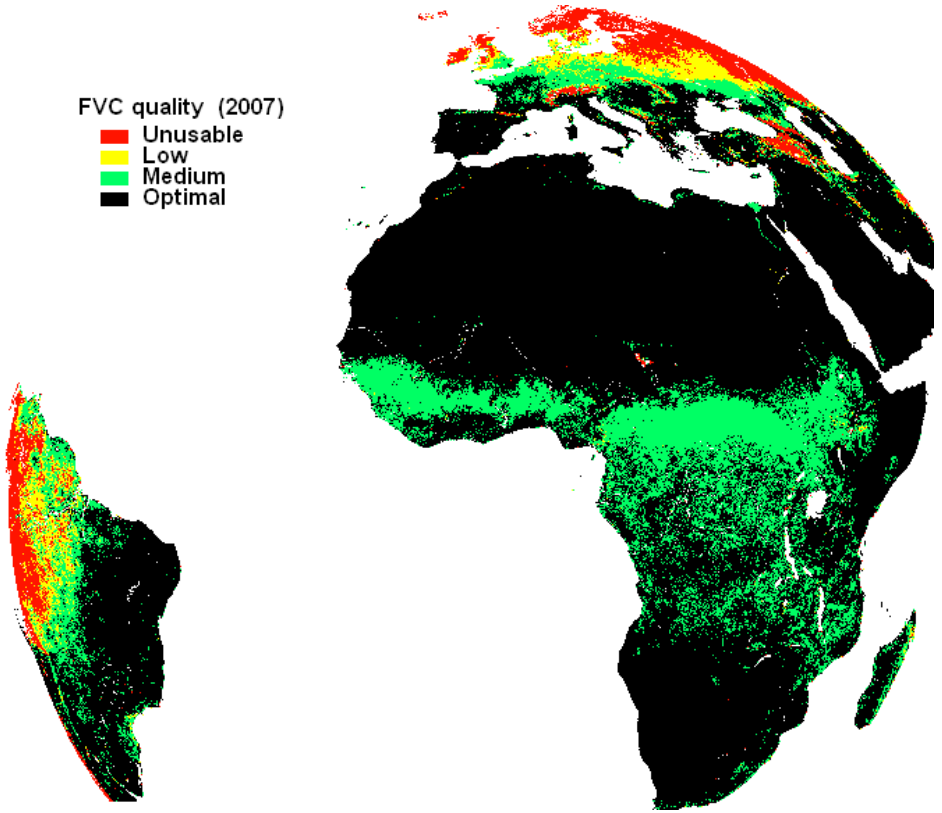




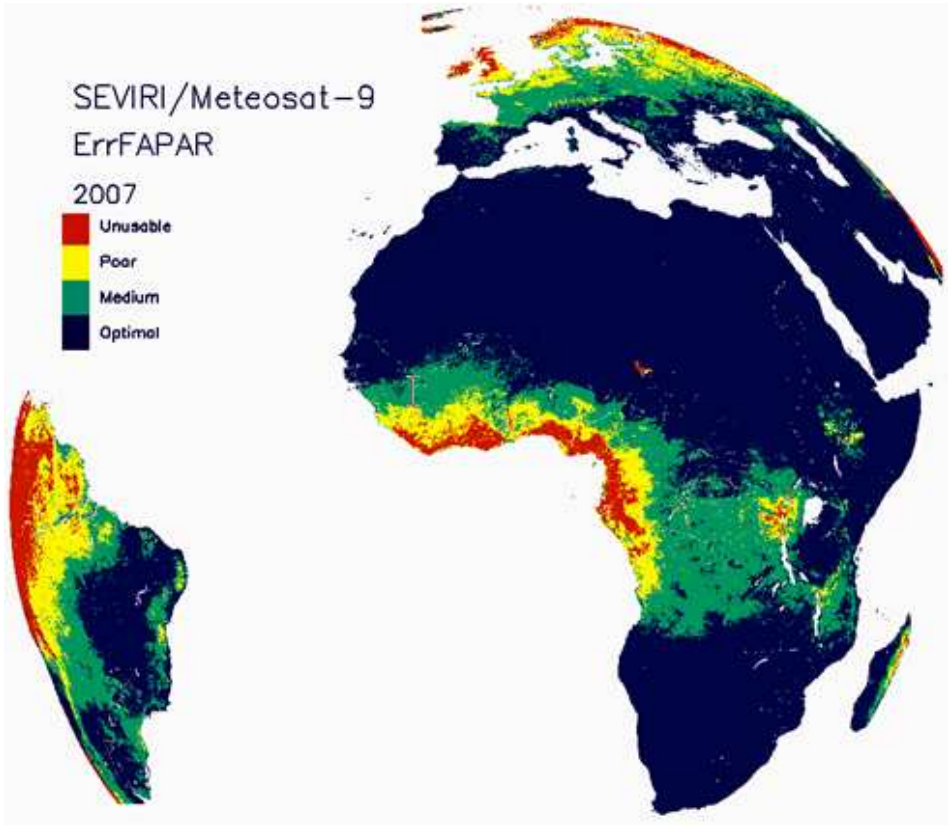


Compliance with the URD

Mean values over 2007



Optimal: Err(FVC)<0.10
Medium: 0.10<Err(FVC)<0.15
Low: 0.15<Err(FVC)<0.20
Unusable Err(FVC)>0.20



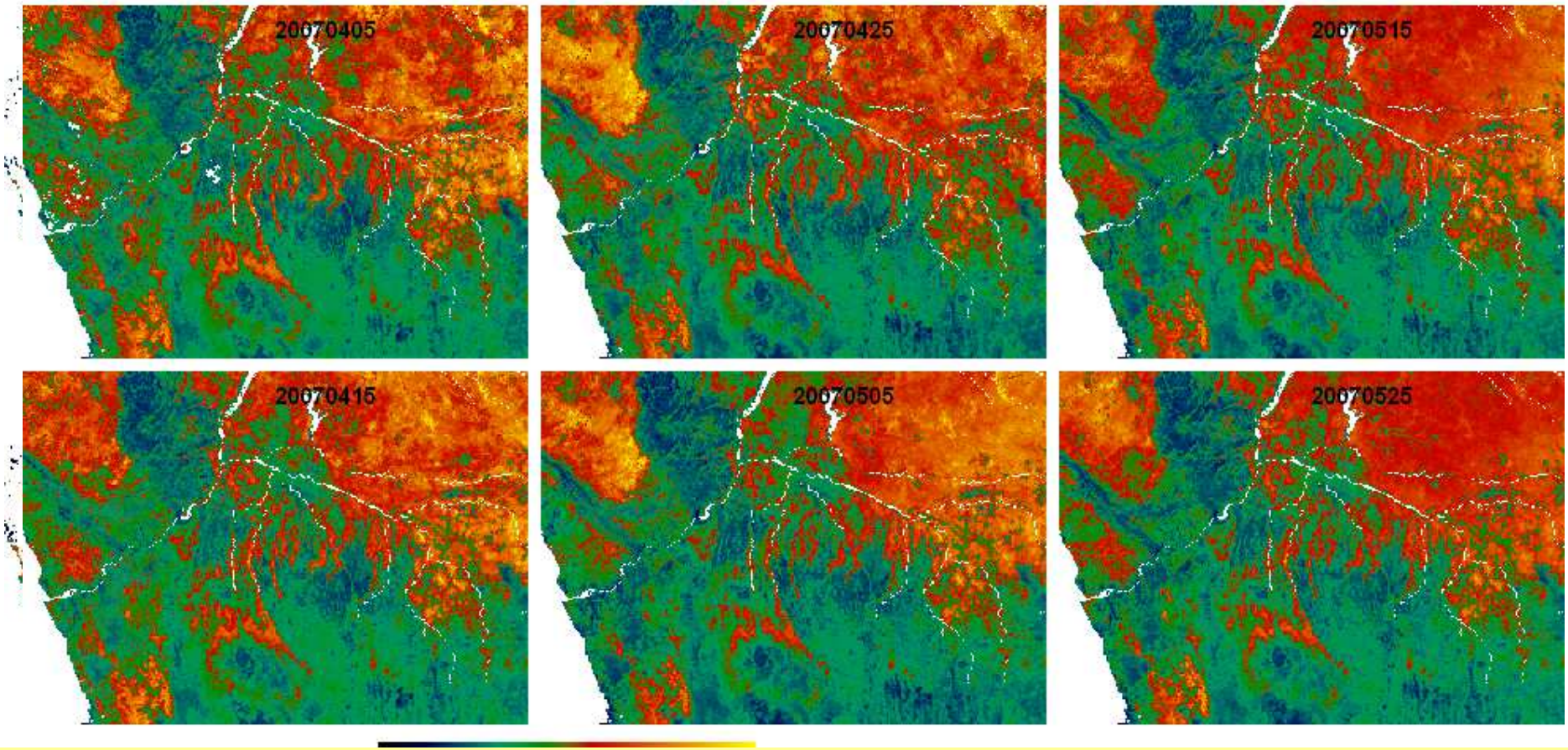
Optimal: Err(FAPAR)<0.10
Medium 0.10<Err(FAPAR)<0.15
Low: 0.15<Err(FAPAR)<0.20
Unusable Err(FAPAR)>0.20

Added value with regard to similar products

Expert knowledge

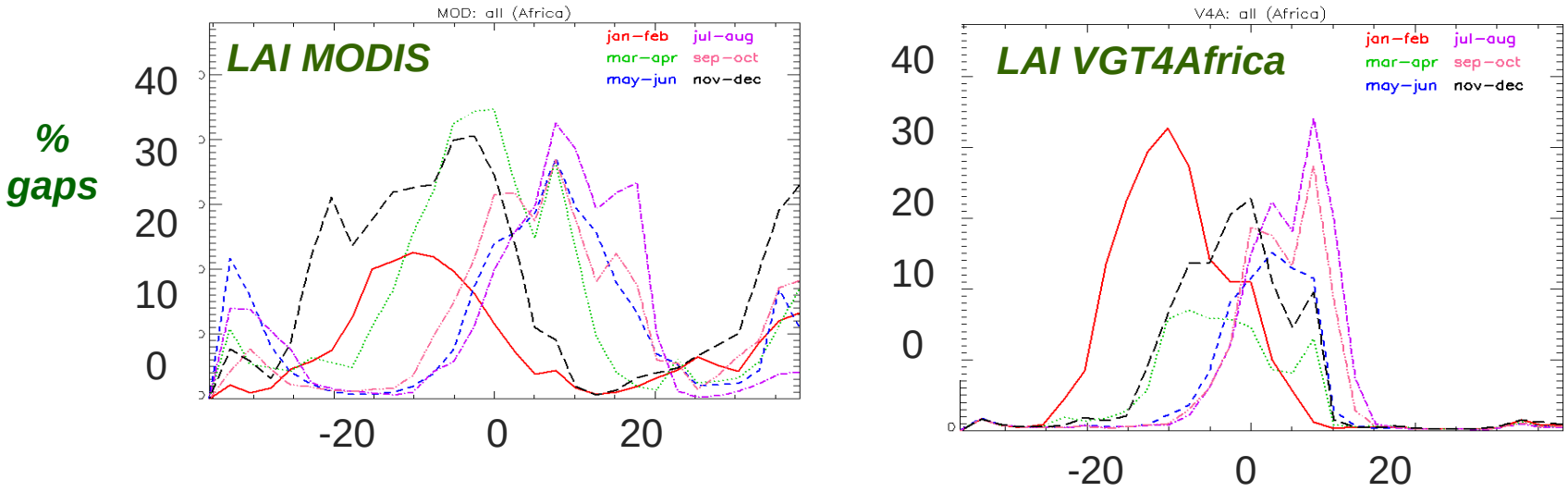
Sequence of products over a 50-day period, S_Africa (0º S, 11.2º E – 8.3ºS, 23.2ºE).

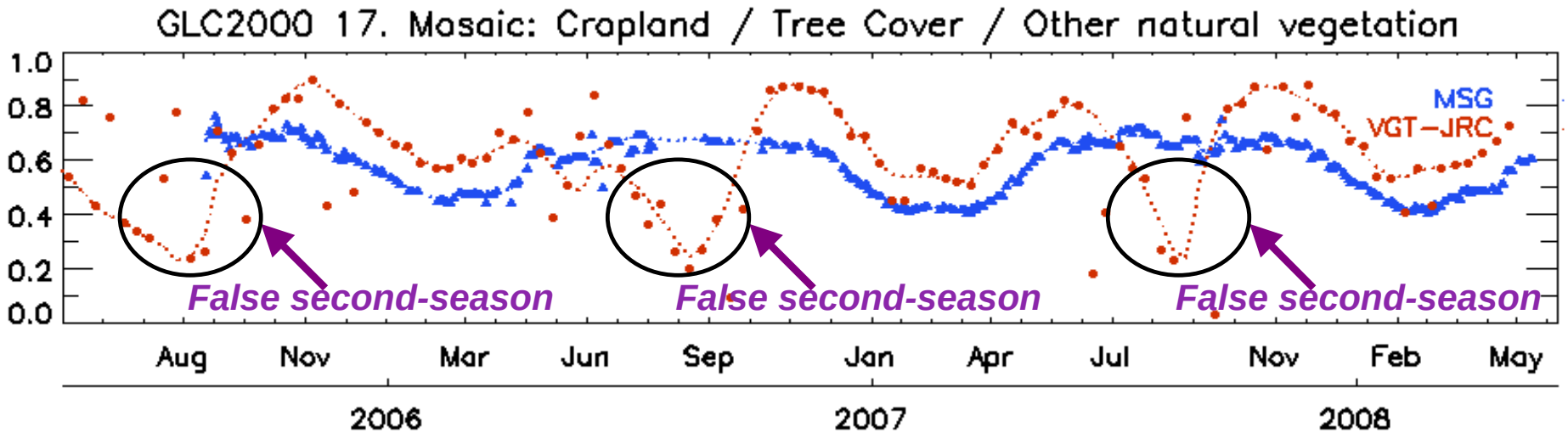
Land-SAF LAI



The temporal continuity and stability of LAI MSG product clearly outperforms that of MODIS product.

Extraction of seasonal information

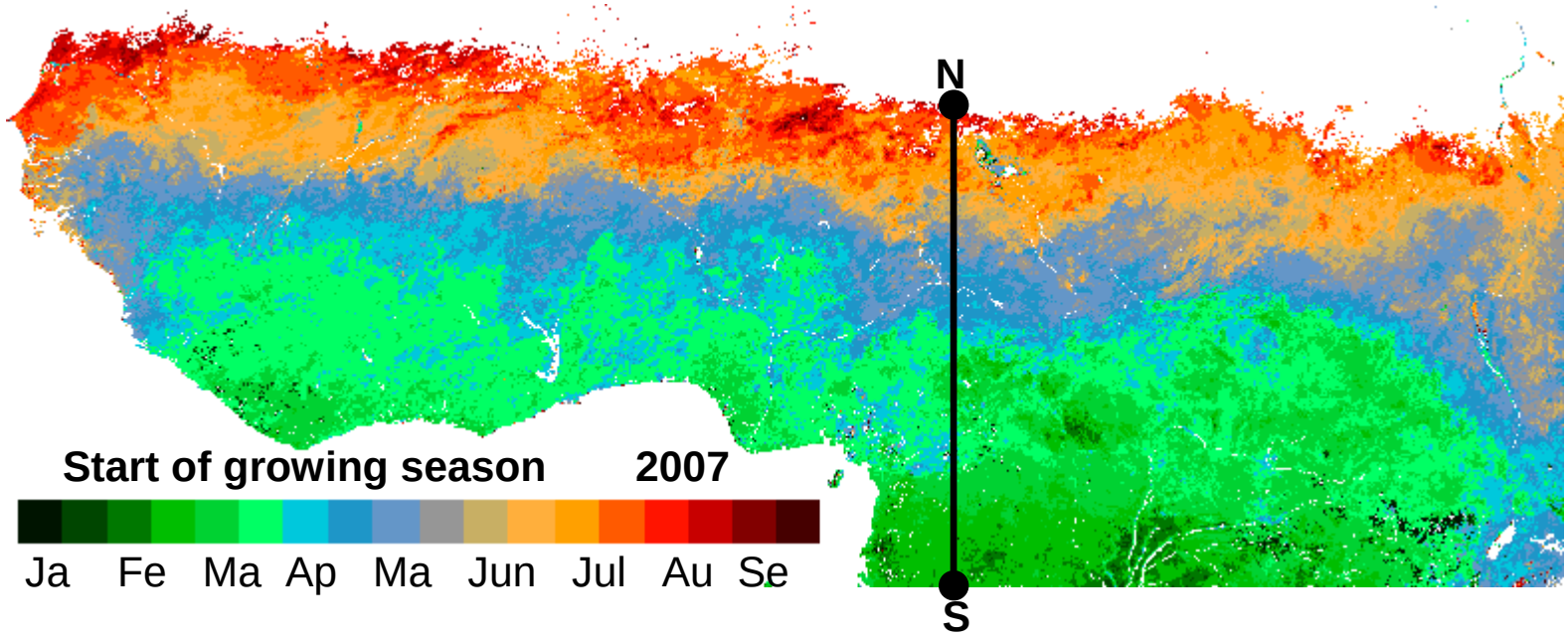


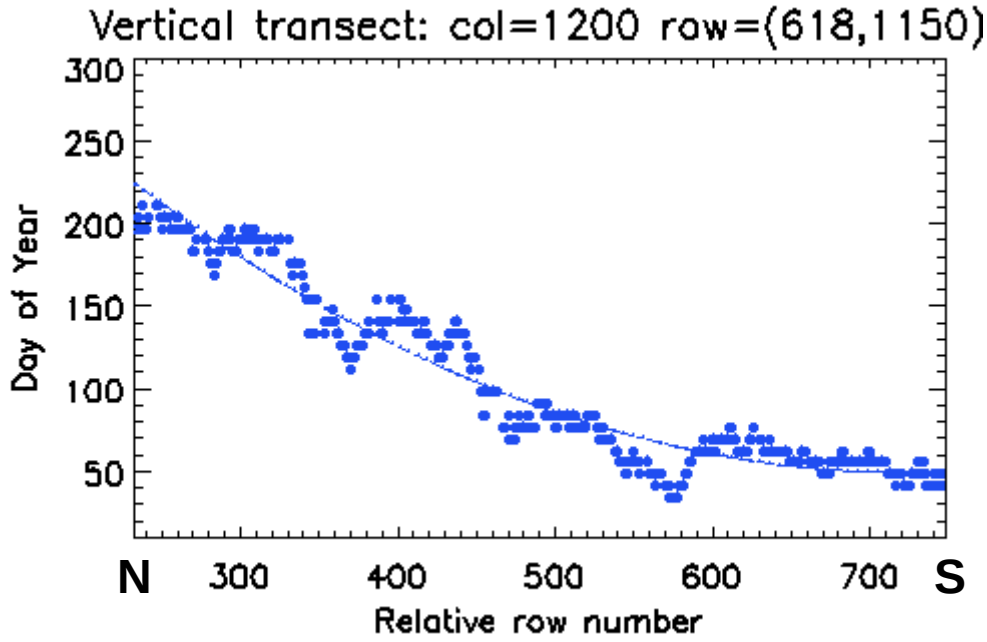


Spatial and temporal continuity (LAI-FVC VEGA have no gaps in Africa

⇒ Robustness against double-seasons false alarms

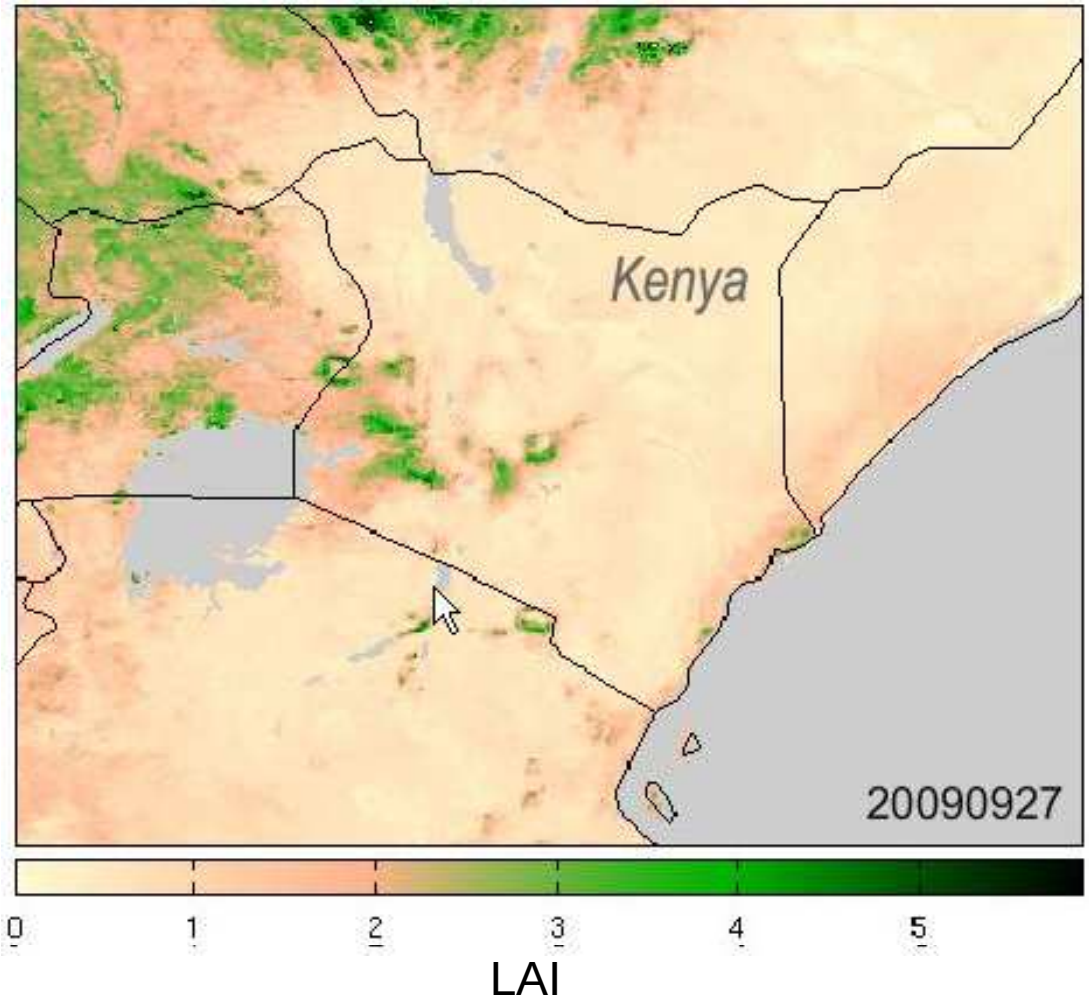
Extraction of phenological parameters





Drought monitoring

SEVERE DROUGHT OVER EAST AFRICA: 10 million people afected (state of emergency)

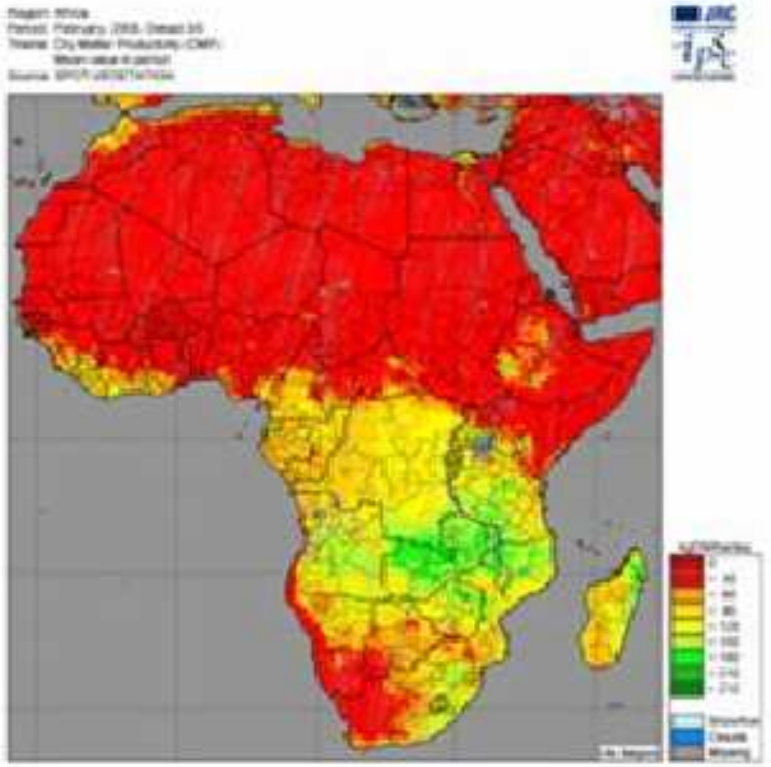


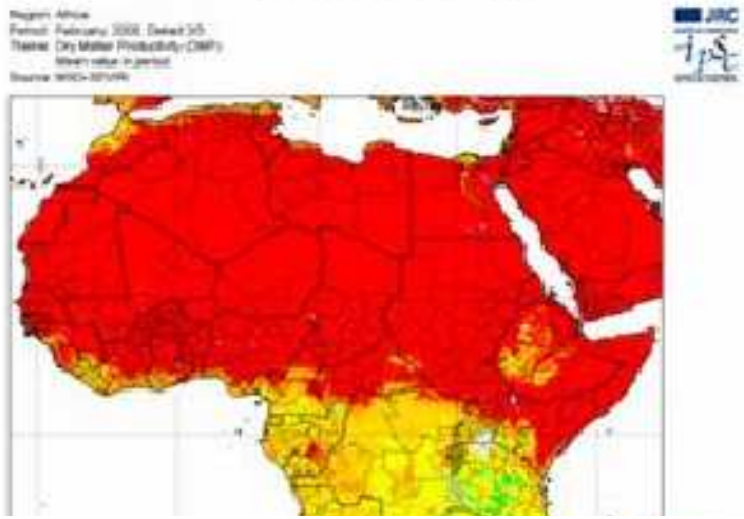
by Isabel Monteiro (**EUMETRAIN**: Monitoring Vegetation from space)
http://www.satreponline.org/landsaf/

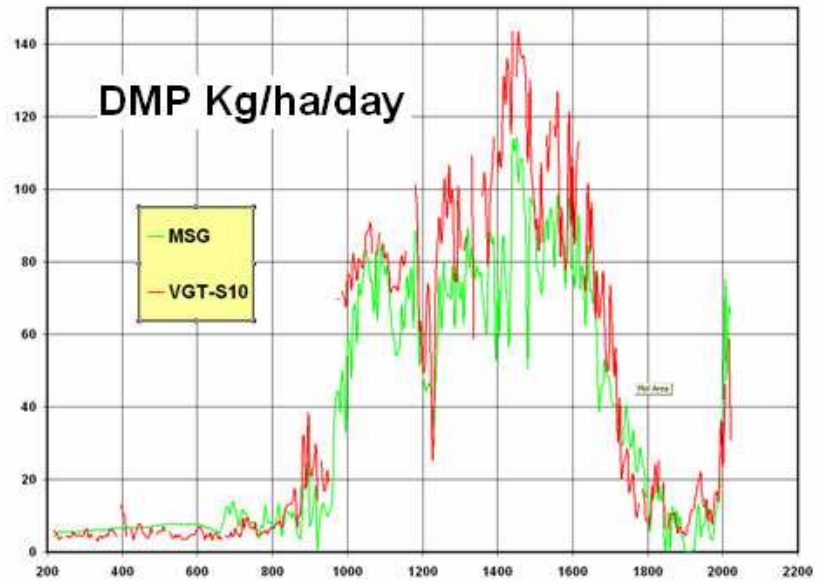
Dry Matter Productivity

DMP as estimated by JRC, based on **FAPAR** from **SPOT** and **MSG**

SPOT-VGT 2008, February, Dekad 3 **MSG-LSA SAF**





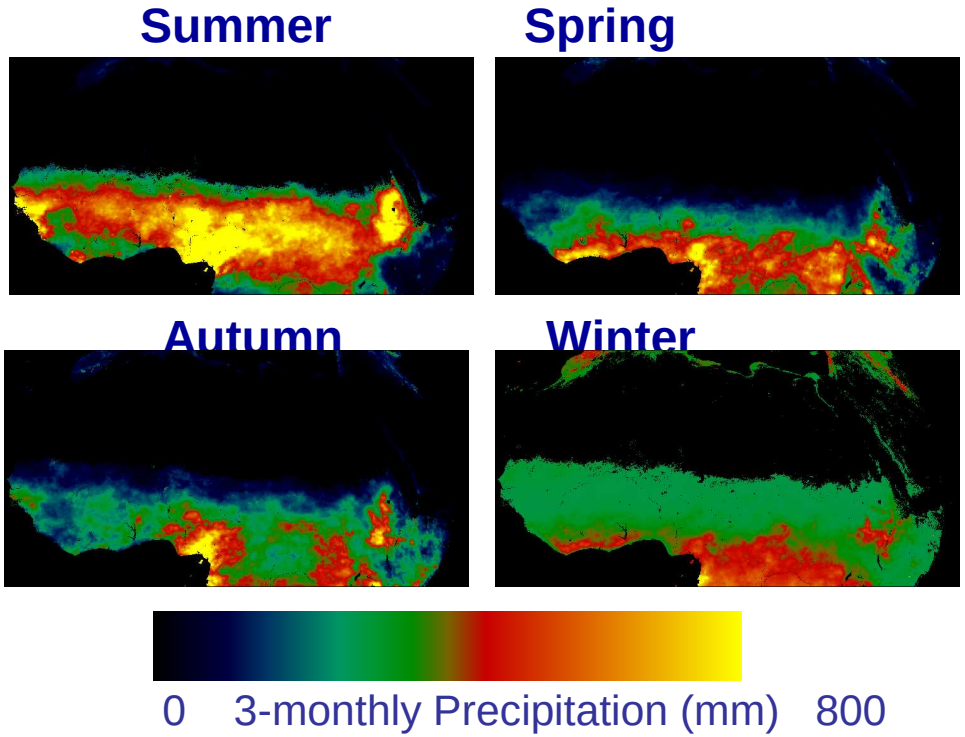


N-S transect through Africa
20° Meridian (Lybia to Cape Town)

by Isabel Monteiro (**EUMETRAIN**)

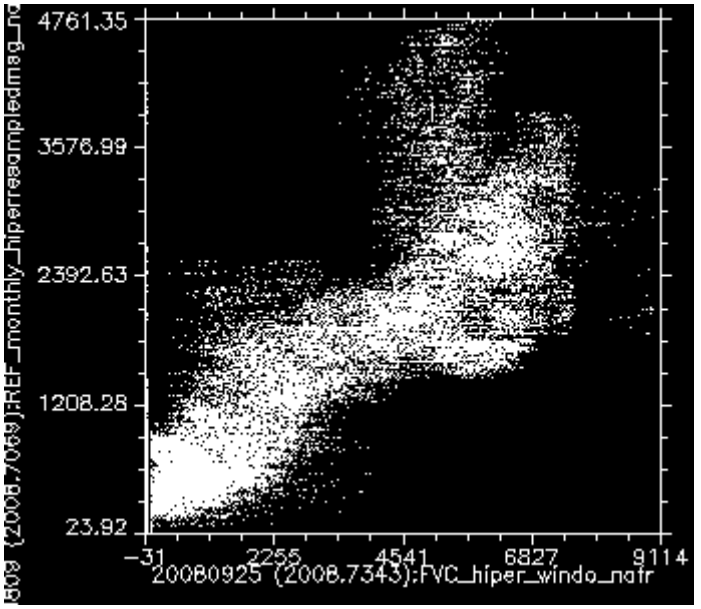
Response to climatic variability

Potential applications



- Vegetation as indicator of land condition over large areas:
  - Variability (e.g. drought) and trends (degradation, deforestation)

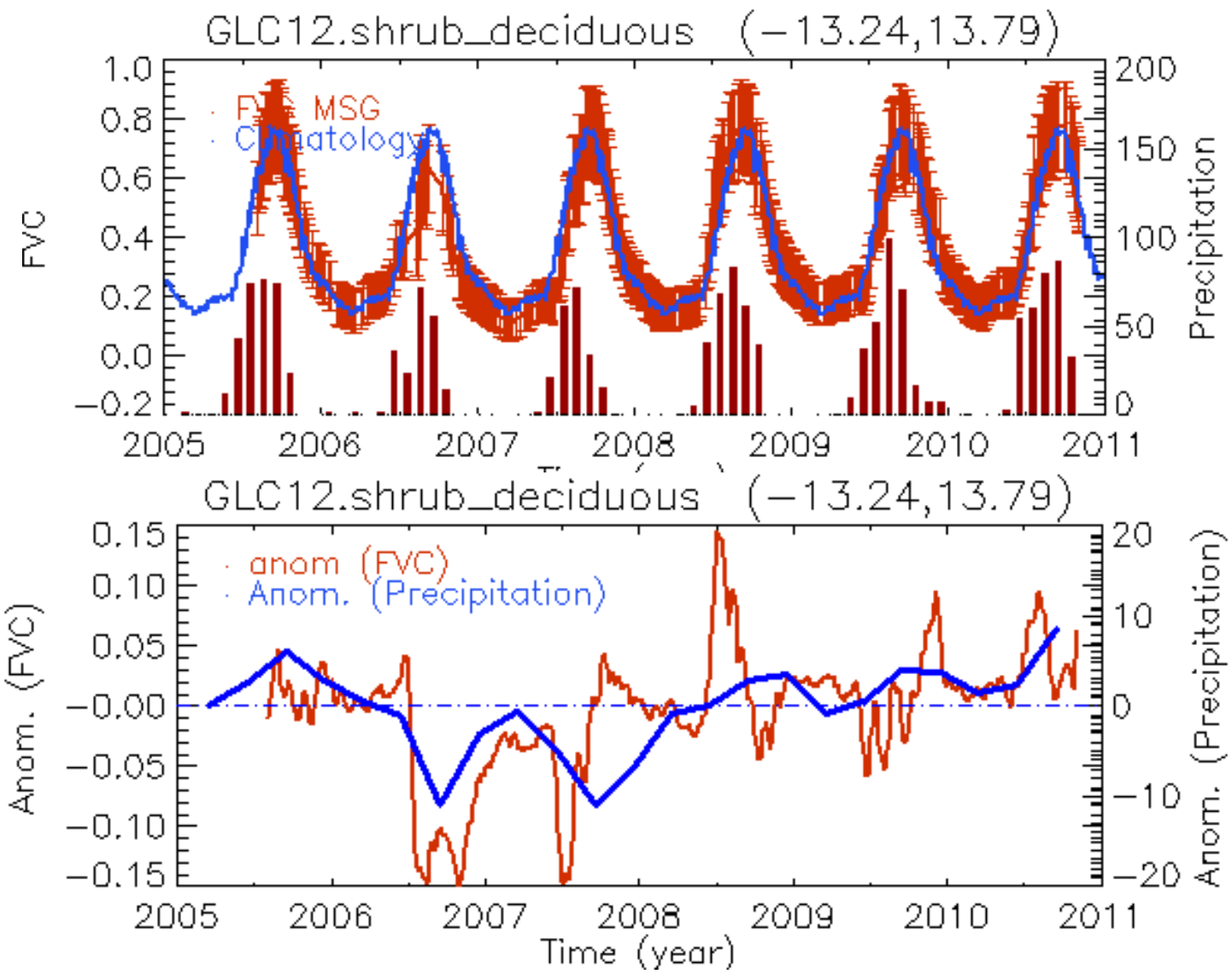
  Applications: crop & yield monitoring, early warning systems, Carbon sequestration, forestry, climate modeling



- 10-day rainfall estimates (RFE 2.0) for Africa from the NOAA Climate Prediction Center (NOAA/CPC) at a spatial resolution of 8-km - monthly and 3-montly accumulated

Vegetation response to climatic variability

Potential applications

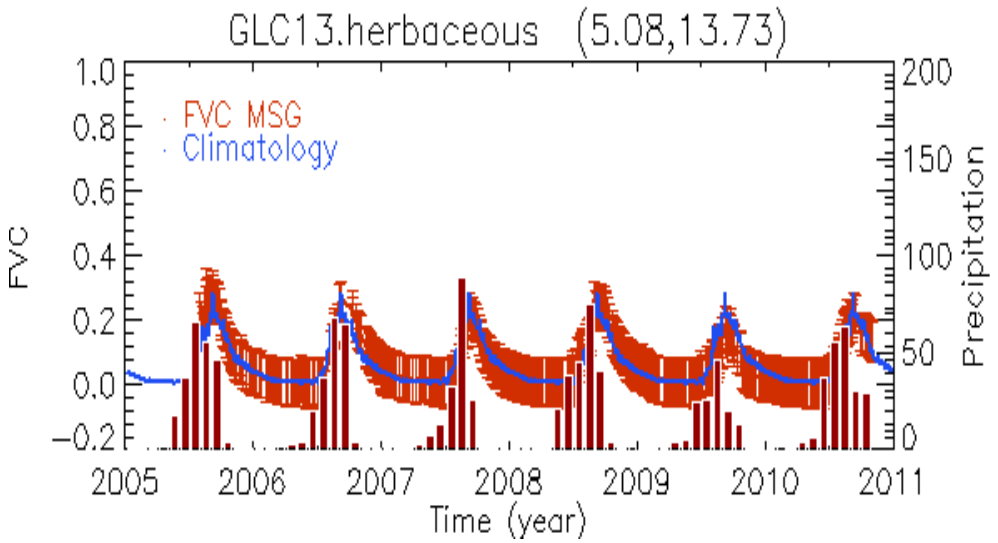


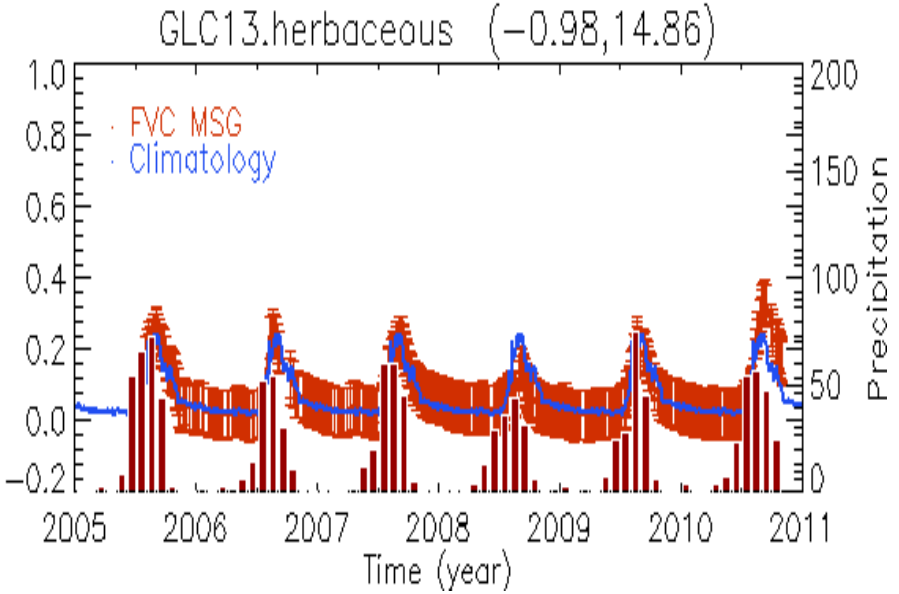
Climatologies based on > 5 years of FVC (SEVIRI/MSG)

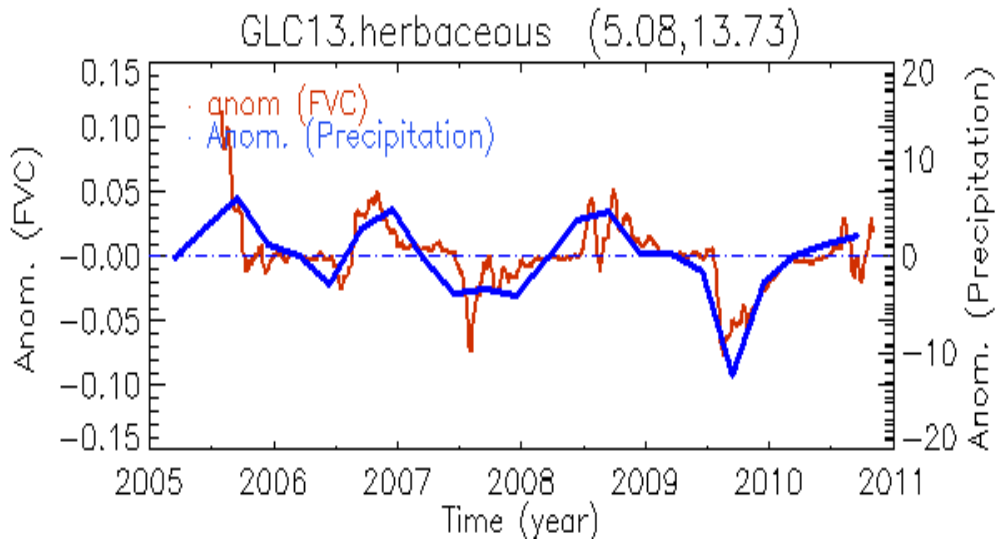
Vegetation response to climatic variability

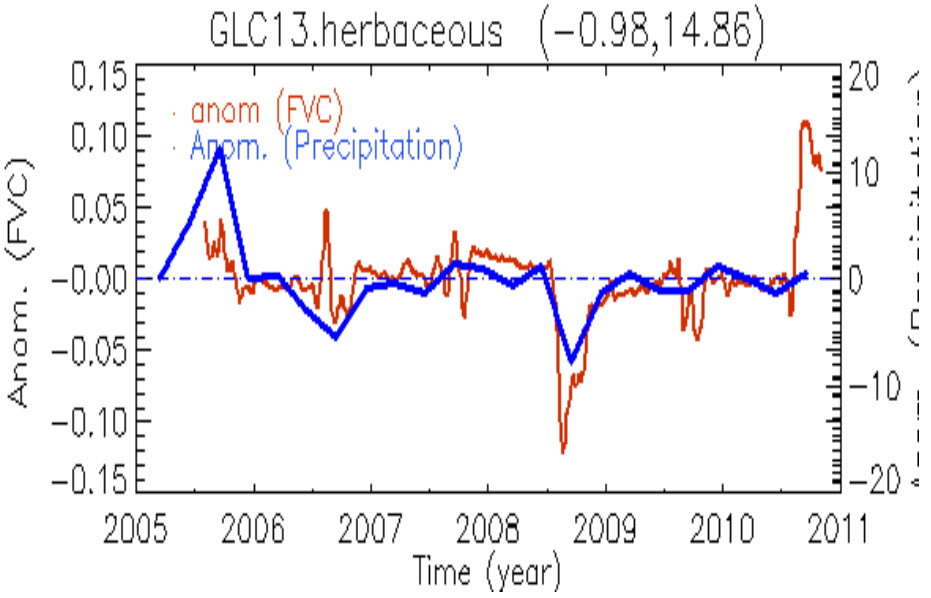
Potential applications

Sahelian semi-arid environments



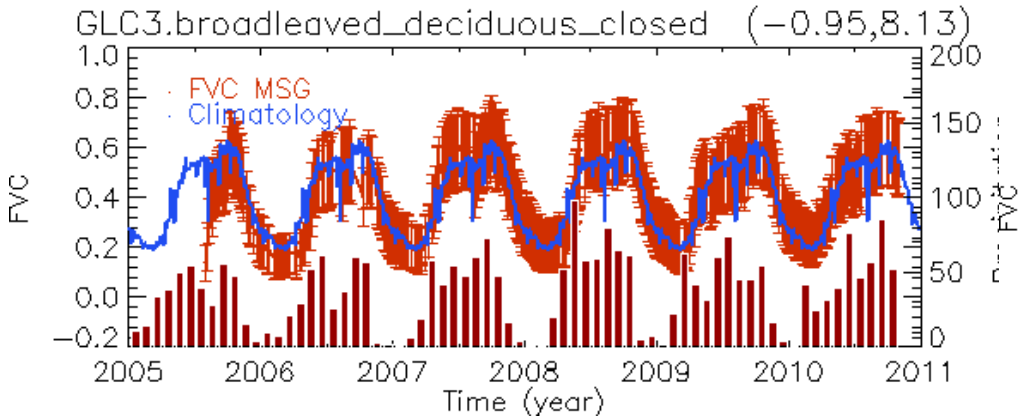


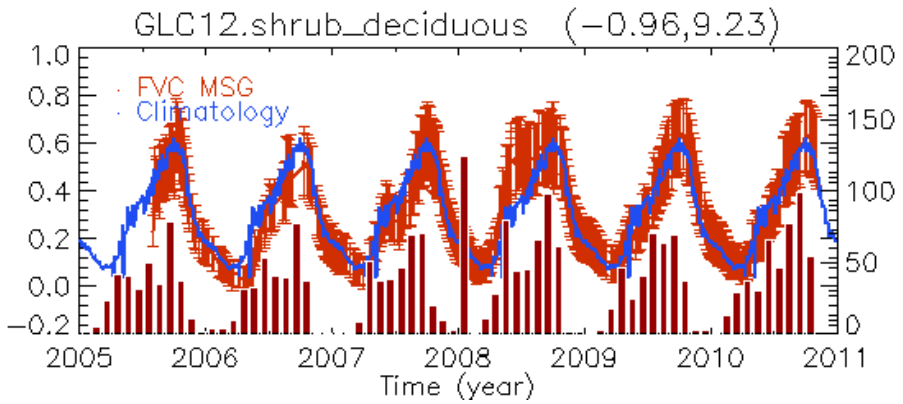


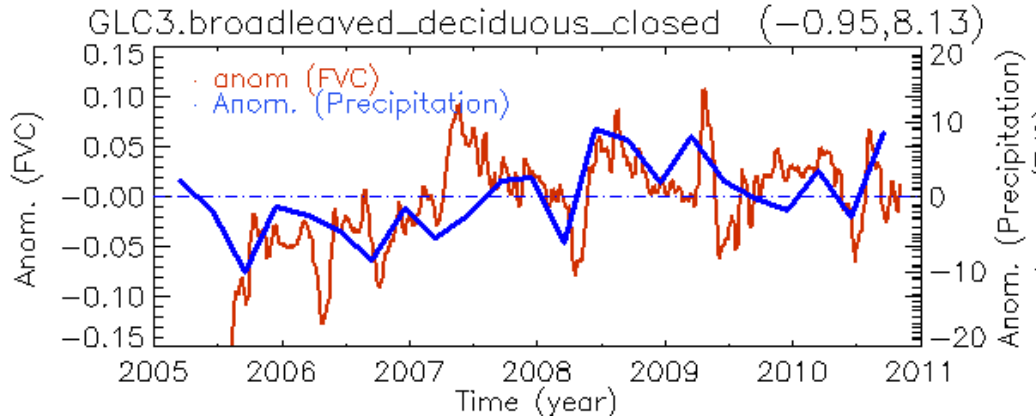


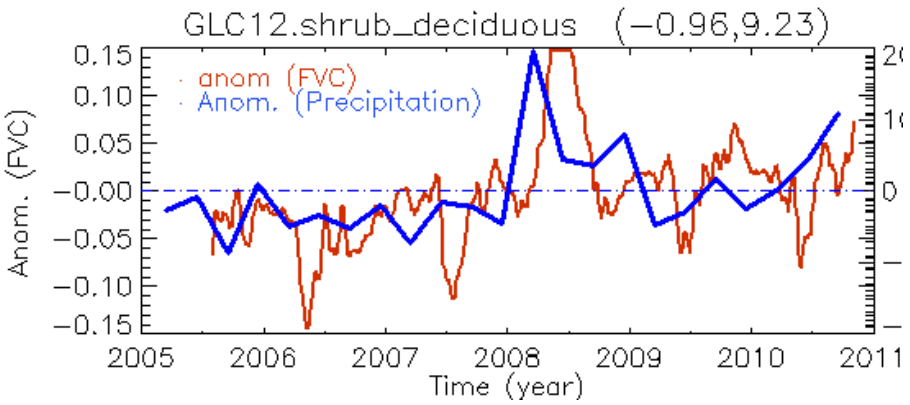
Vegetation response to climatic variability

More humid bioclimatic regions



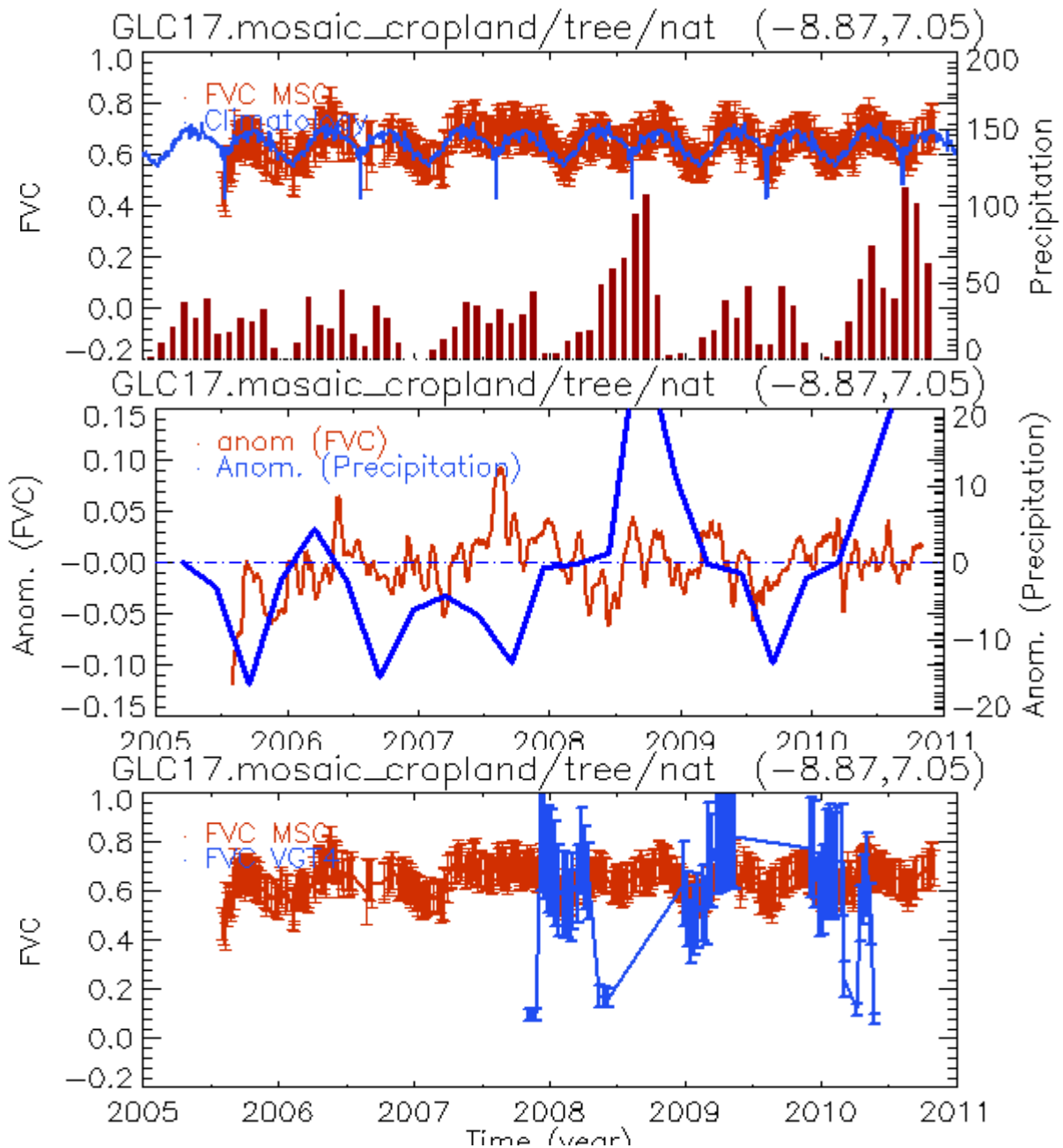






Vegetation response to climatic variability

Potential applications

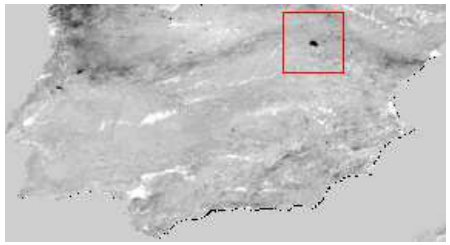


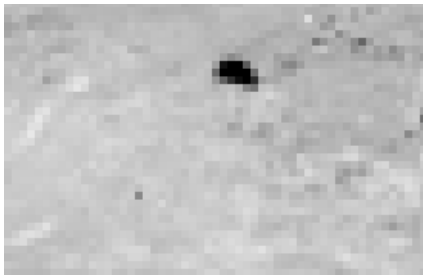
- Humid climates
- evergreen BLF

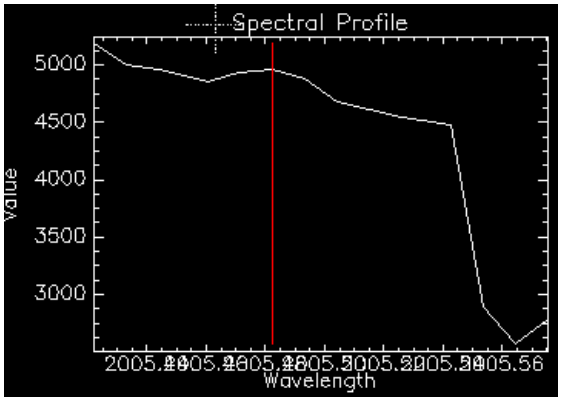
Vegetation response to forest fires

- **Riba Saelices (Gudalajara, Spain)**

  16 July 2005

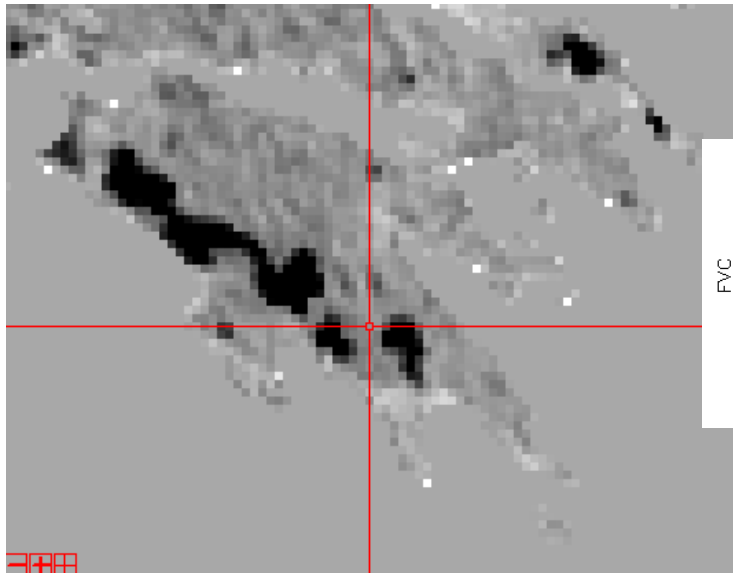




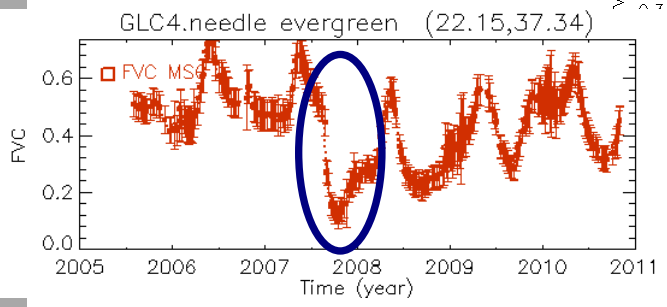


- **Penopoleso Peninsula (Greece)**

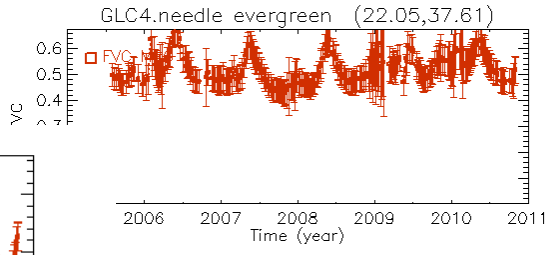
  31 August 2007

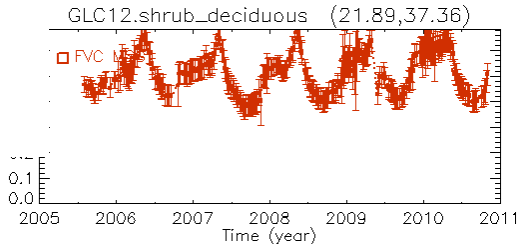


Affected area



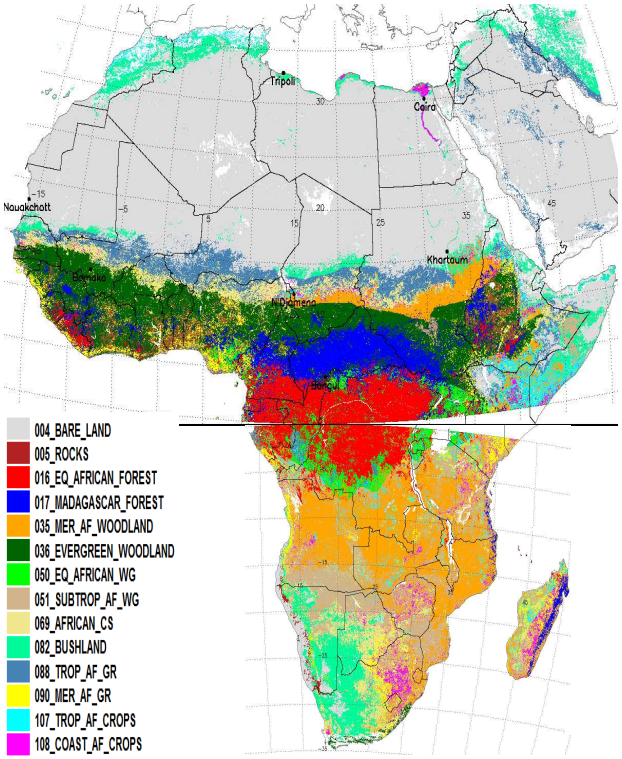
Non-Affected areas



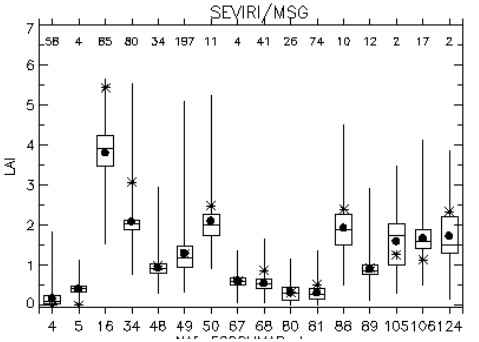


Synergy with ECOCLIMAP

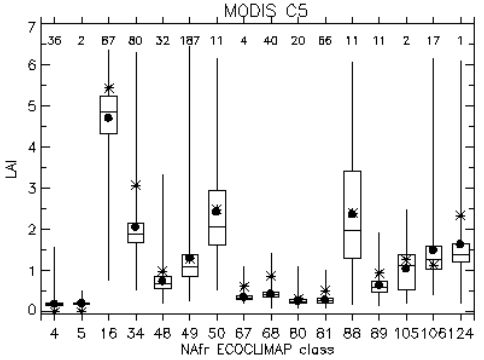
Potential applications



SEVIRI



MODIS



	Spatial	Temporal
External	1.39	0.33
Internal	0.31	0.08
Rel (%)	82.1	81.2

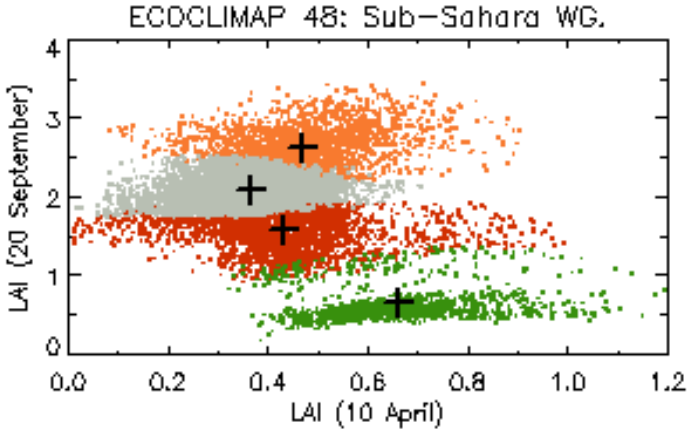
The SPATIAL subdivision into main ECOCLIMAP classes retains the 72-82.1% of the total variance (remaining is due to intra-ecosystem variability unaddressed by ECOCLIMAP).

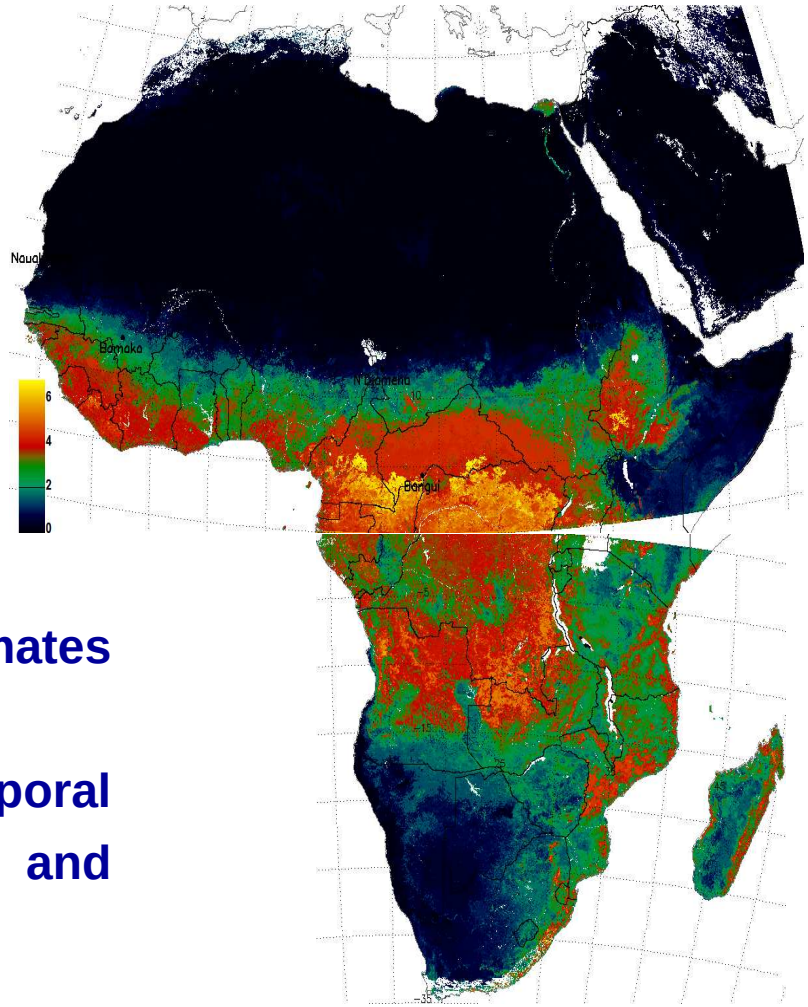
the TEMPORAL variance is clearly dominated by the annual cycle (more than 80%)

MODIS and SEVIRI values are highly consistent.

Synergy with ECOCLIMAP

Potential applications





See related poster

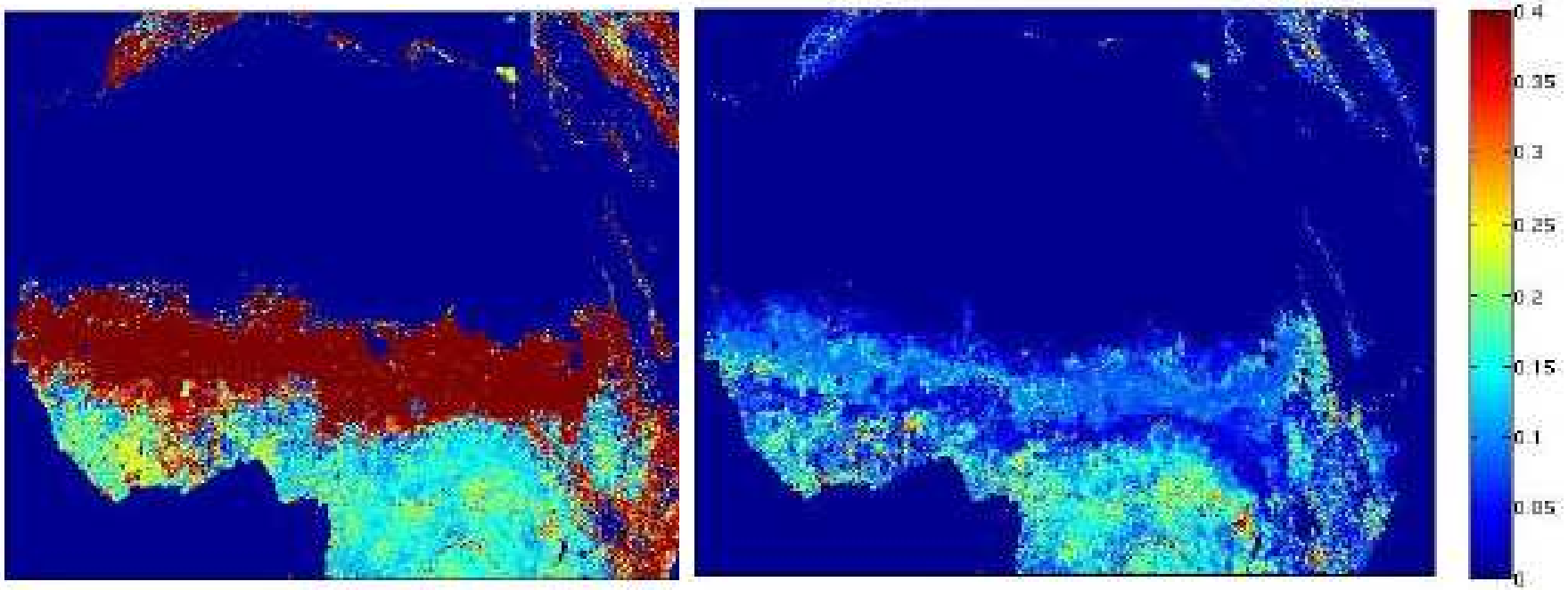
Methodology base on clustering: daily estimates at the original ECOCLIMAP resolution.

Advantages: inter-annual variability, temporal continuity required for climate and environmental applications.

Improve energy balance models

NRT estimation of evapotranspiration

Example: Relative uncertainty of evapotranspiration estimates (14th of May 2007).



ECOCLIMAP LAI

LSA-SAF VEGA LAI

RMI (Royal Meteorological Institute):
N Ghilain, A. Arboleda and F. Gellens-Meulenberghs, 2009, Improvements of a surface energy balance model by the use of MSG-SEVIRI derived vegetation parameters

The EUMETSAT Network of Satellite Application Facilities

LSA SAF
Land Surface Analysis

Capability of SEVIRI/MSG for large-scale monitoring of vegetation condition

J. García-Haro, F. Camacho, A. Verger, J. Meliá

VNIVERSITAT DE VALÈNCIA

EOLAB
Earth Observation Laboratory
Spin-off Universitat de València