

Land Surface Analysis SAF - 2010 User workshop

Comparison of MSG-SEVIRI and SPOT-VEGETATION data for vegetation monitoring over Africa

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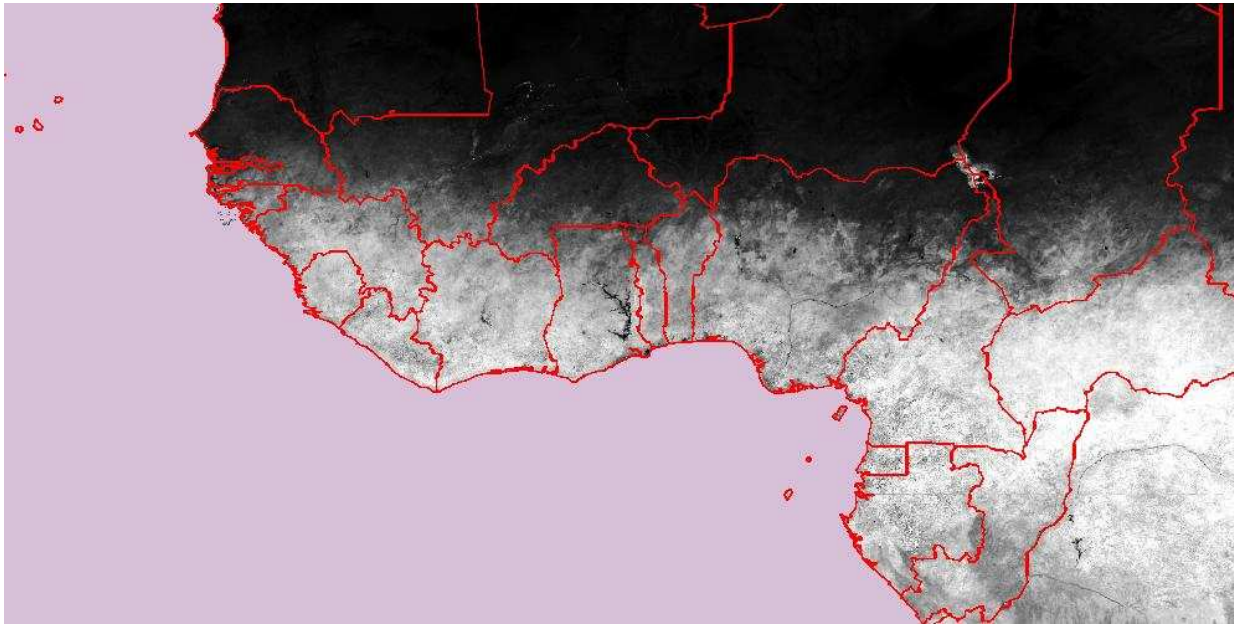
Objectives

- Comparison of NDVI from coarse resolution satellites : MSG-SEVIRI, SPOT-VEGETATION
NOAA-AVHRR, EOS-MODIS
- Comparison of FVC product delivered by LSA-SAF with an estimation of FVC derived from SPOT-VEGETATION



Comparison of NDVI from coarse resolution satellites

- Test area : West Africa
(25 W to 25 E, 20 N to 5 S)



- Test period: may – june 2006

Methods (NDVI)

- Re-sampling data at same spatial resolution (0.05 degree)
- Comparison of MSG NDVI with data from other sensors, taking into account different temporal compositing periods (10, 15 or 16 days)
- Analysis of temporal profiles (daily data) from MSG-SEVIRI for several land-use/land-cover classes (GLC-2000)



AMMASAT NDVI Archive from MSG SEVIRI

source : LSA SAF+ POSTEL; start = sept. 2005

- Image format : NetCDF
- Compositing period = 1 day (from normalized reflectances computed with a 5 days timescale)
- Projection = Plate carrée, Datum = WGS84
- Pixel size = 0.05 degree (~ 5,6 km)
- Coverage: West Africa (25 W to 25 E, 20 N to 5 S)
- Nb. of samples = 1000
- Nb. of lines = 500
- Data type = signed integer (NDVI x 10000)



SPOT-VEGETATION NDVI S10 archive

source : VITO; start = may 1998

- Image format : HDF
- Compositing period = 10 days
- Projection = Plate carrée, Datum = WGS84
- Pixel size = 0.008929 degree (~ 1km)
- Coverage : African continent
- Nb. of samples = 9633
- Nb.of lines = 8177
- Data type : byte
- $NDVI = 0.004 * CN - 0.1$



NOAA-AVHRR NDVI archive

source : NASA-GIMMS; start = july 1981

- Image Format : GeoTIFF
- Compositing period= 15 days
- Projection = Plate carrée, Datum = WGS84
- Pixel size = 0.07272727 degree (~ 8km)
- Global coverage
- Num. of samples = 4950
- Num. of lines = 2091
- Data type = signed integer (NDVI x 10000)
- Water and missing data NDVI = - 0.1



TERRA-MODIS NDVI Archive MOD13C1

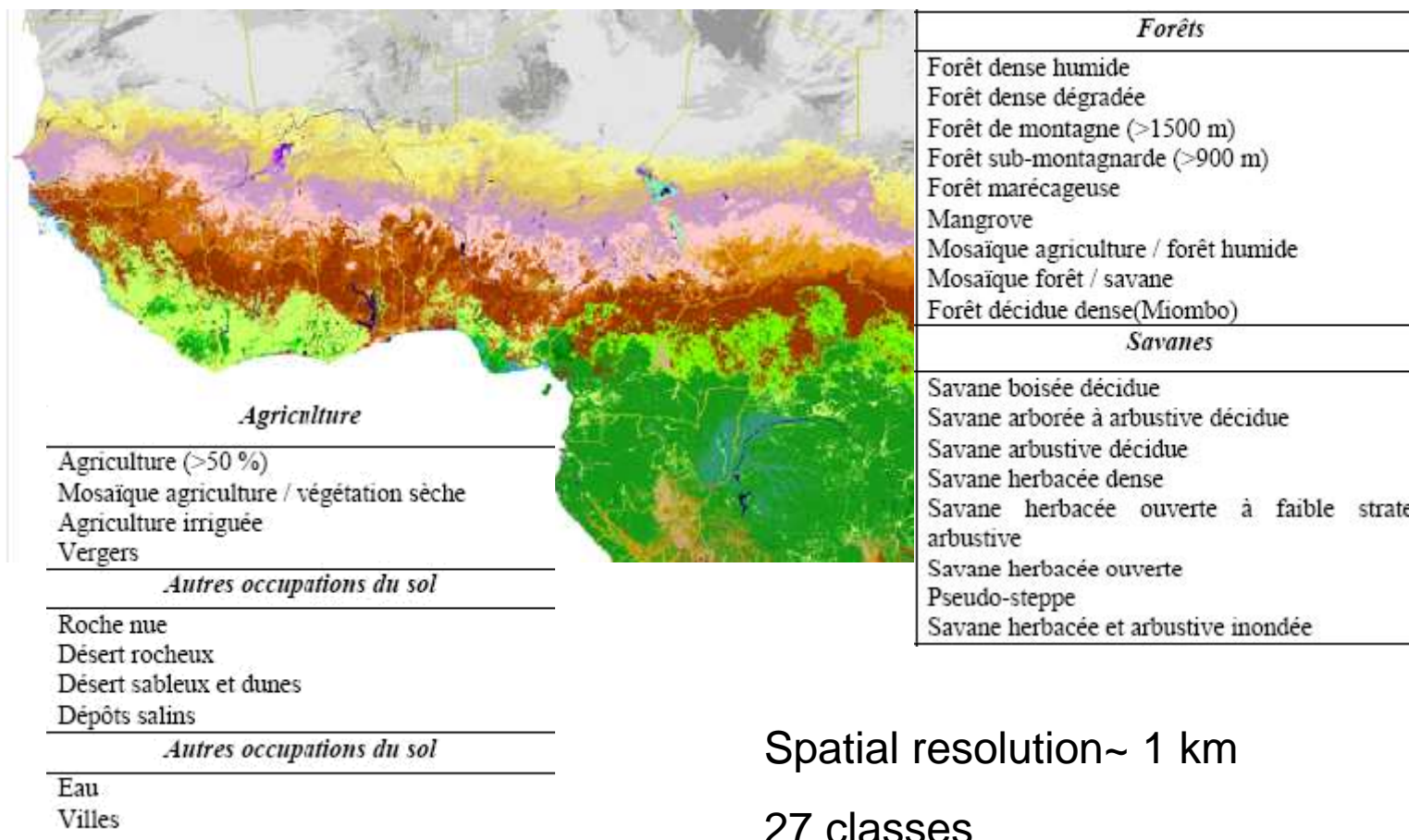
source : NASA-WISP; start = march 2000

- Image Format : HDF
- Compositing period= 16 days
- Projection = Plate carrée, Datum = WGS84
- Pixel size = 0.05 degree (~ 5,6km)
- Global coverage
- Nb. of samples = 7200
- Nb. of lines = 3600
- Data type = signed integer (NDVI x10000)



Global Land Cover GLC 2000

from SPOT VEGETATION 2000 + radar data ERS et JERS + DMSP data+ global DEM GTOPO30 + auxilliary data (available maps)



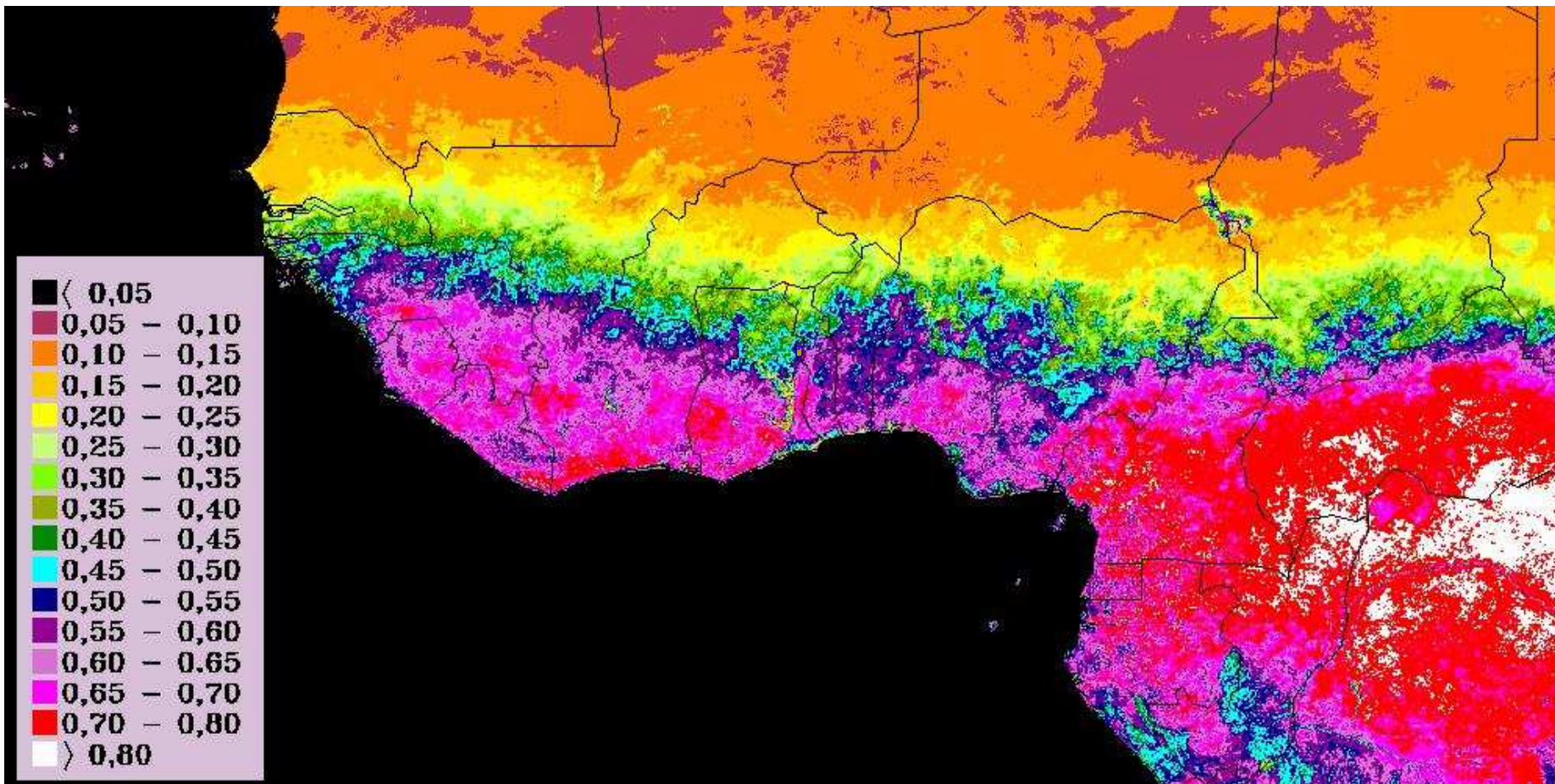
Spatial resolution~ 1 km

27 classes

NDVI from MSG-SEVIRI

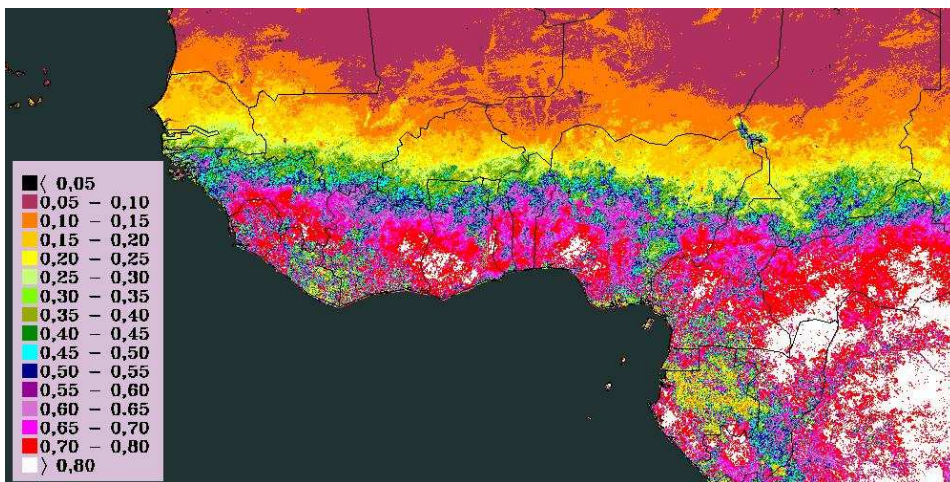
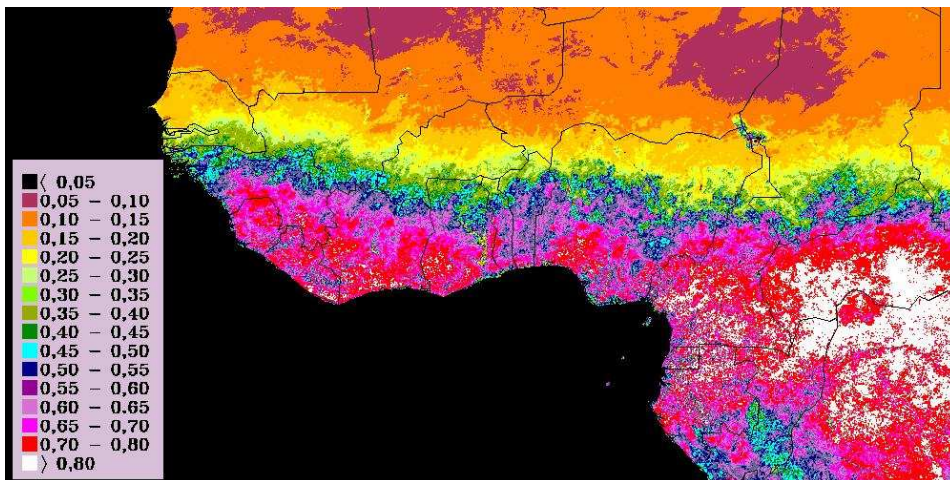
4 may – 23 june 2006

mean of 51 daily images



Comparison between MSG-SEVIRI and SPOT-VEGETATION

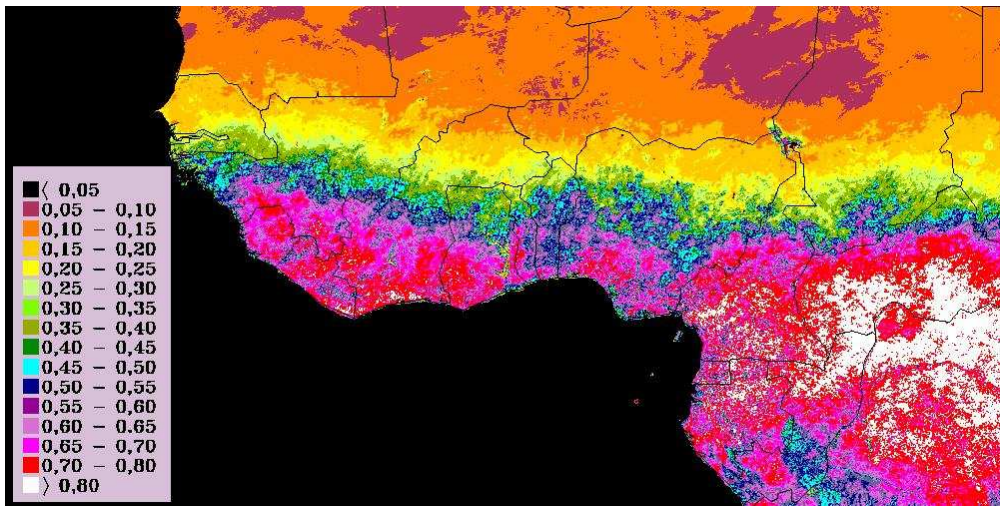
21 – 31 may 2006



SPOT-VEGETATION
1 image (16 days compositing period)

Comparison between MSG-SEVIRI and NOAA-AVHRR

16 – 31 may 2006

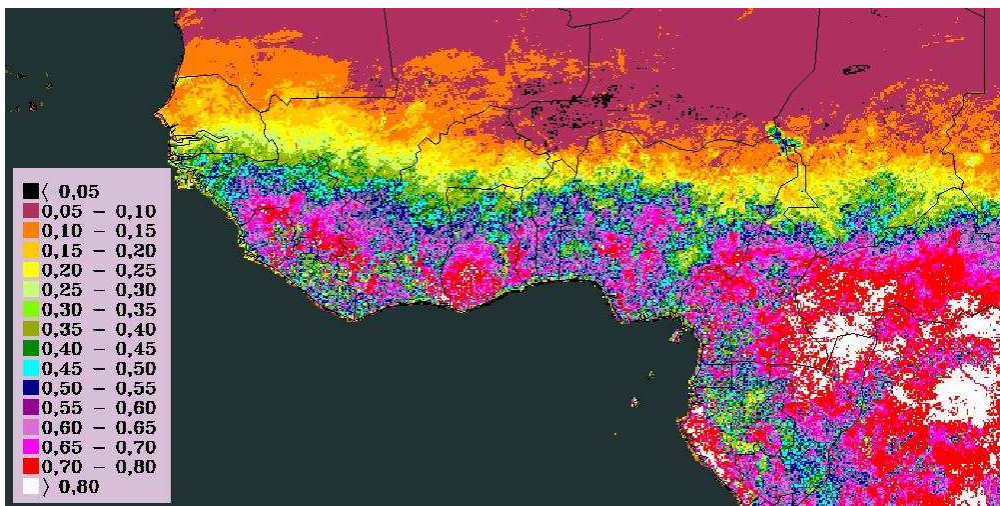


MSG - SEVIRI
mean of 16 daily images

In red, difference > 0.2

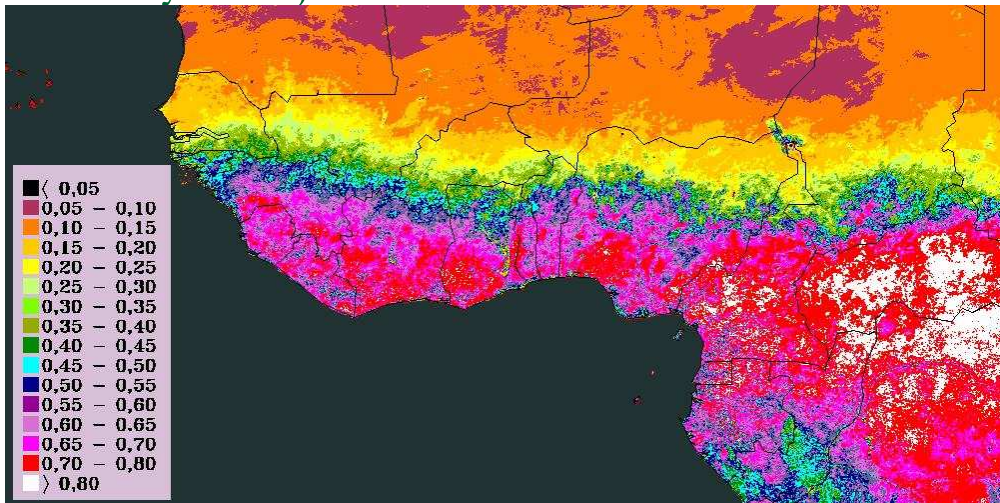


NOAA-AVHRR
1 image (16 days compositing period)

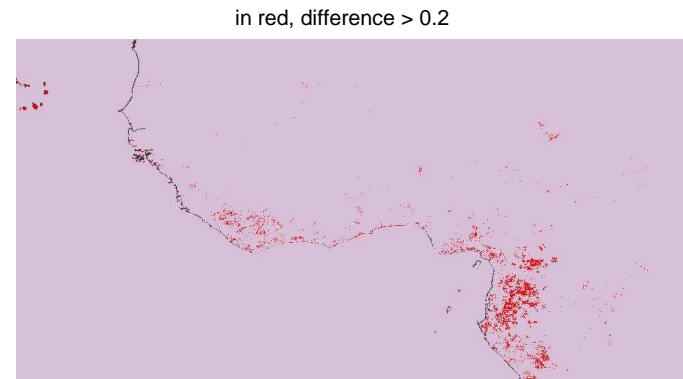


Comparison between MSG-SEVIRI and TERRA-MODIS

25 may – 9 june 2006



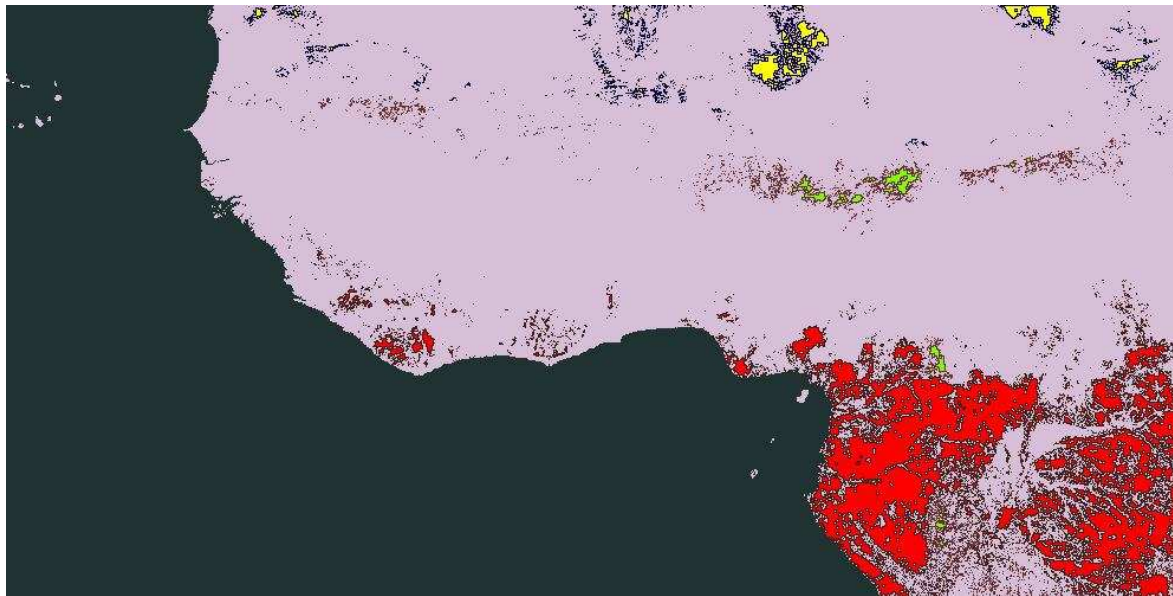
MSG - SEVIRI
mean of 16 daily images



TERRA-MODIS
1 image (16 days compositing period)

Daily NDVI from MSG-SEVIRI

- Period: may – june 2006
- Test areas defined using 3 GLC 2000 classes



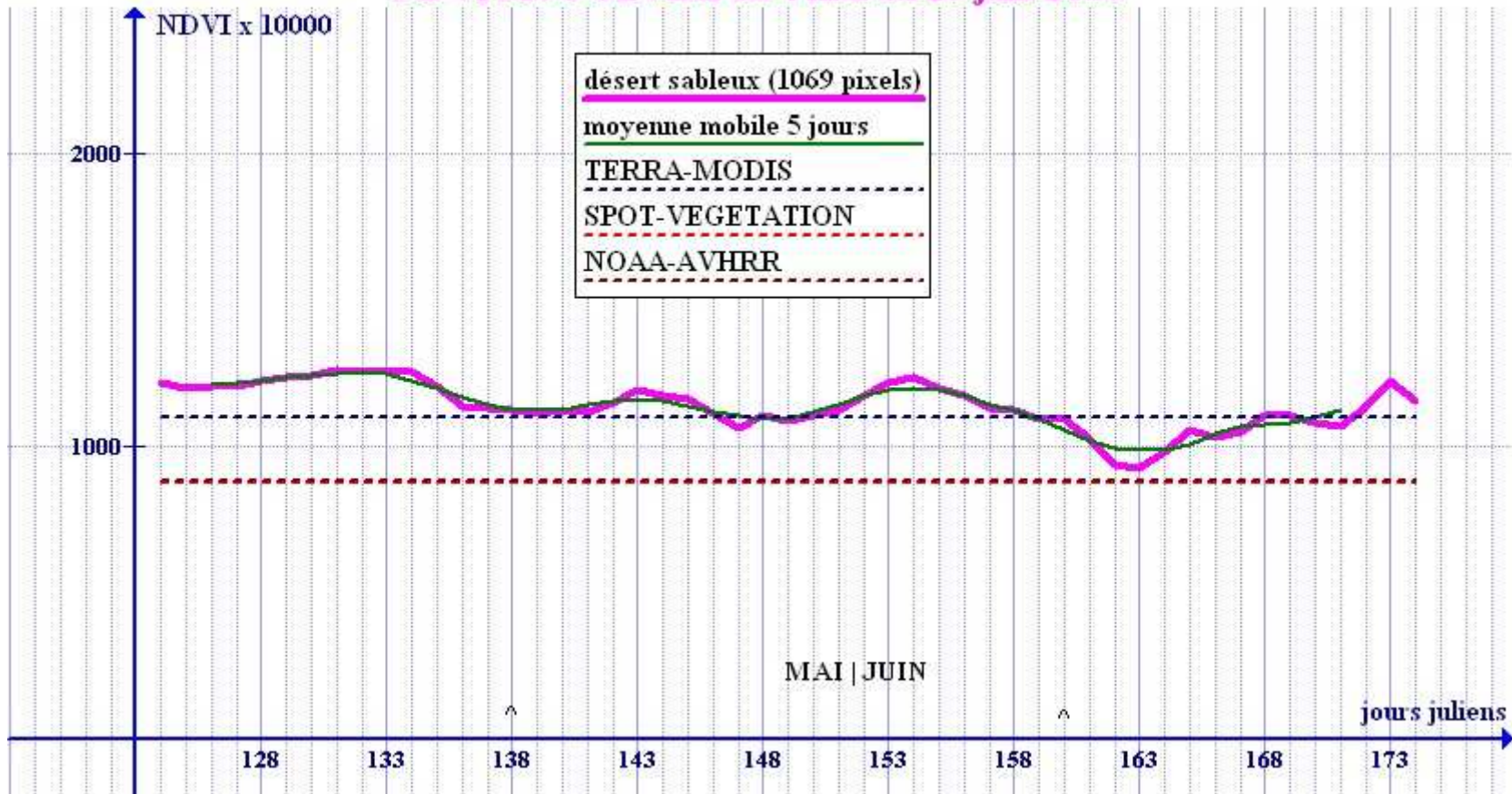
sandy desert

dense herbaceous savanna

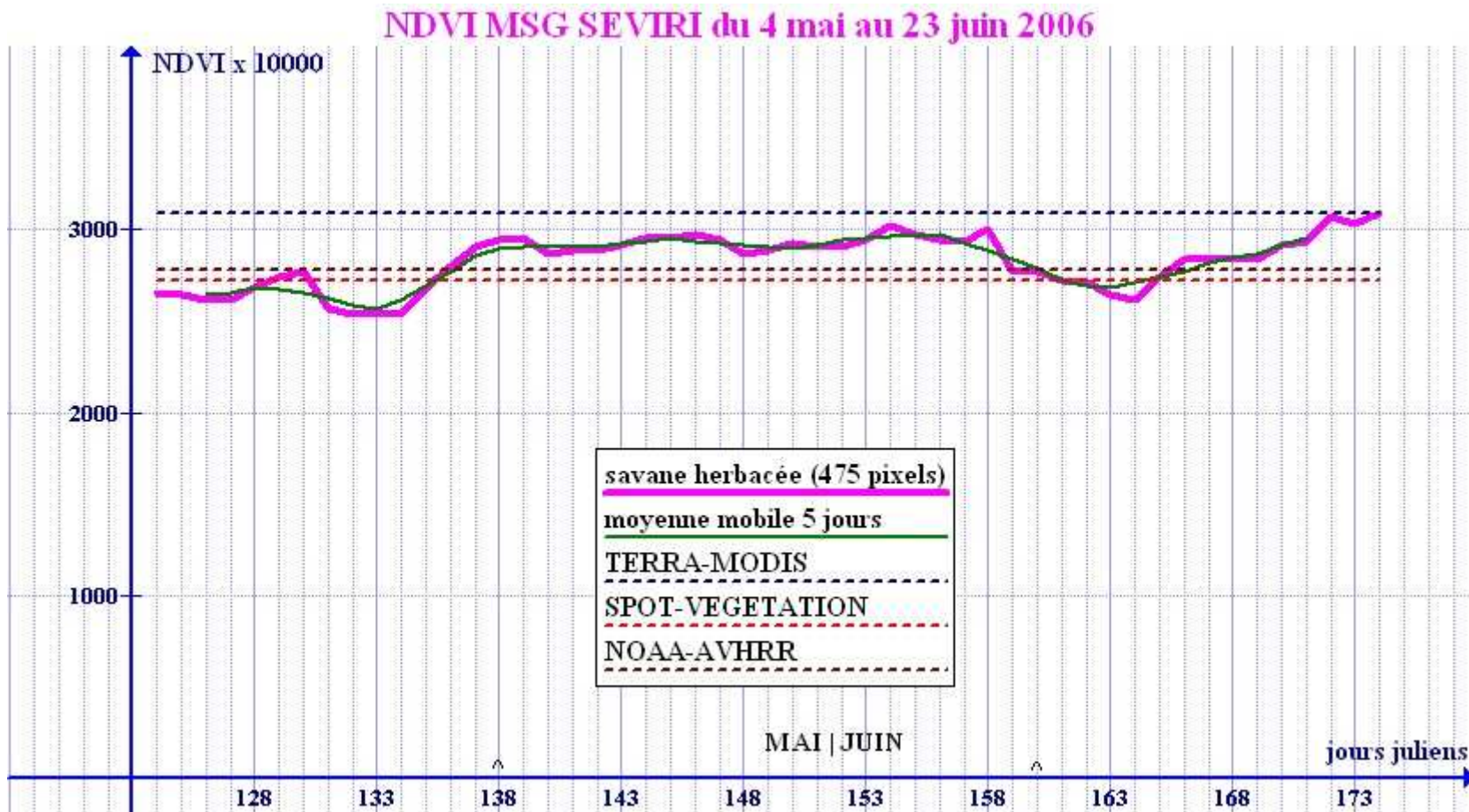
dense evergreen forest

Daily NDVI from MSG-SEVIRI

NDVI MSG SEVIRI du 4 mai au 23 juin 2006



Daily NDVI from MSG-SEVIRI

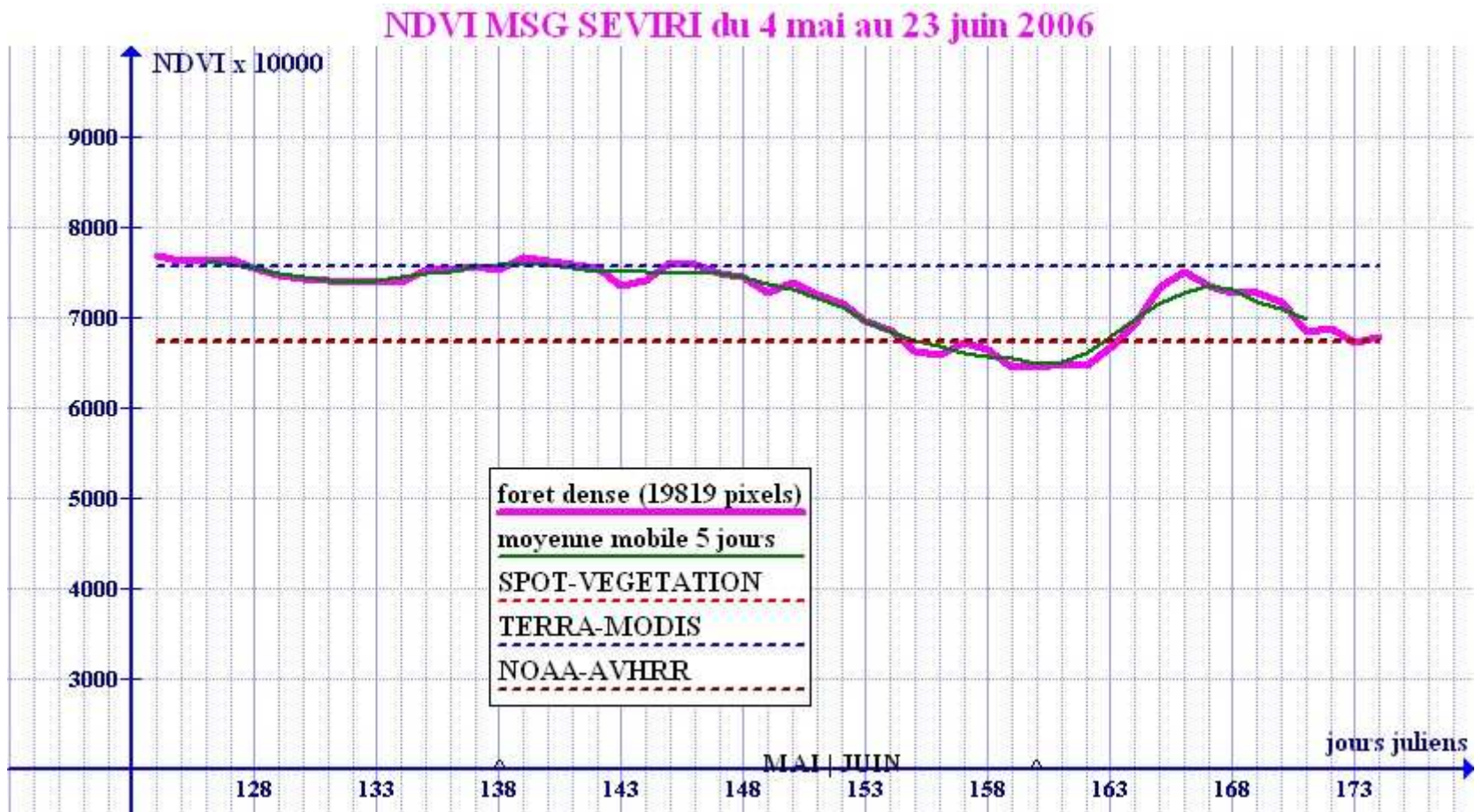


Bernard Lacaze

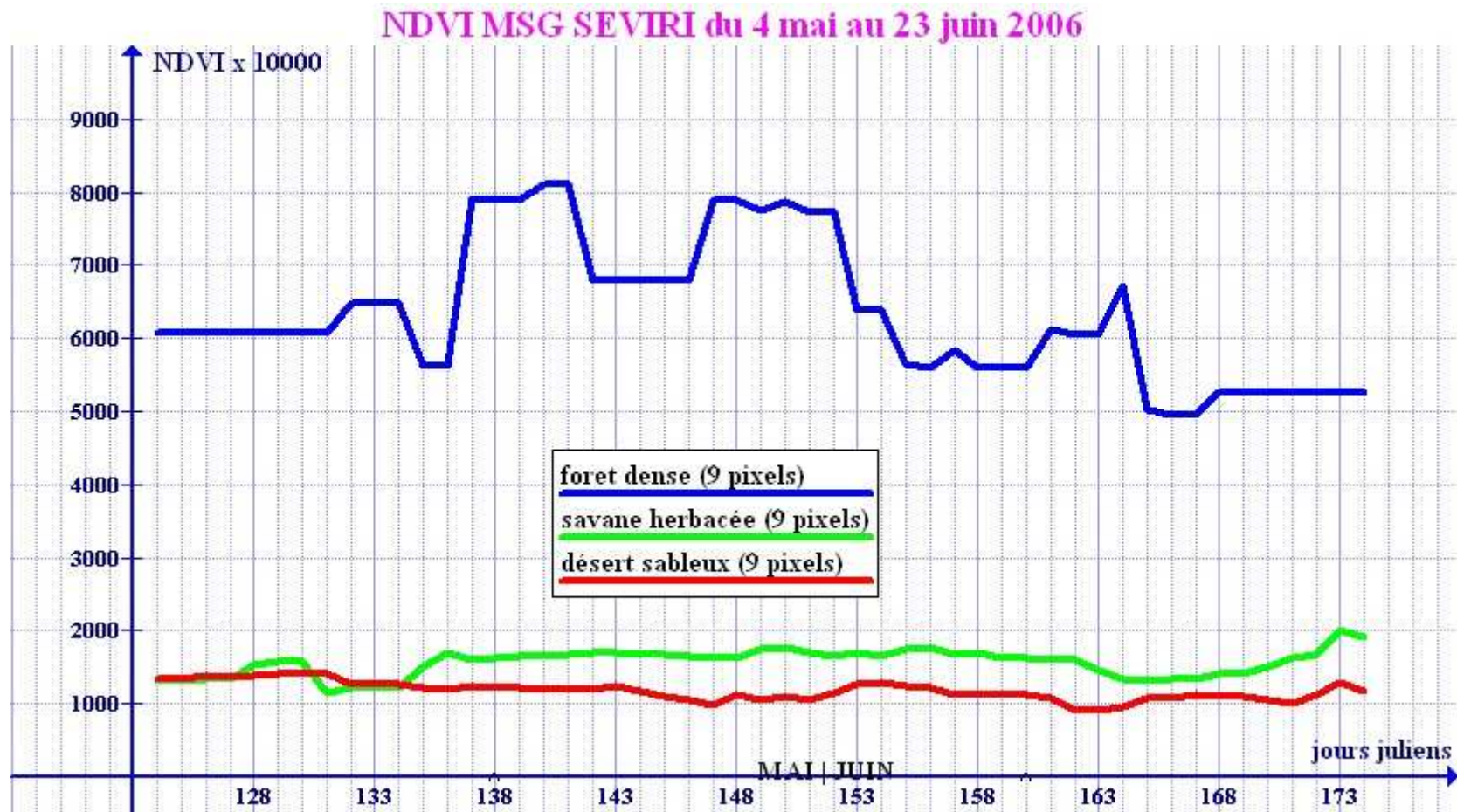
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workshop



Daily NDVI from MSG-SEVIRI



Daily NDVI from MSG-SEVIRI



Daily NDVI from MSG-SEVIRI

NDVI MSG SEVIRI du 4 mai au 23 juin 2006



Conclusions from NDVI comparison

- Results of test areas: mean NDVI values from coarse resolution sensors may differ from about 10% (MODIS = higher values, SPOT and AVHRR lower values, MSG intermediate values)
- MSG-SEVIRI is the only data source giving reliable results in areas with persistent cloudiness (i. e. during monsoon period in West Africa);
- Unexpectedly high day to day variations in NDVI values derived from MSG-SEVIRI in some “invariant” areas like evergreen dense forest



Comparison of Fraction of Vegetation Cover derived from MSG-SEVIRI and SPOT-VEGETATION

- Period: may – june 2007
- MSG-SEVIRI daily values
- SPOT-VEGETATION: FVC from 10 days compositing period



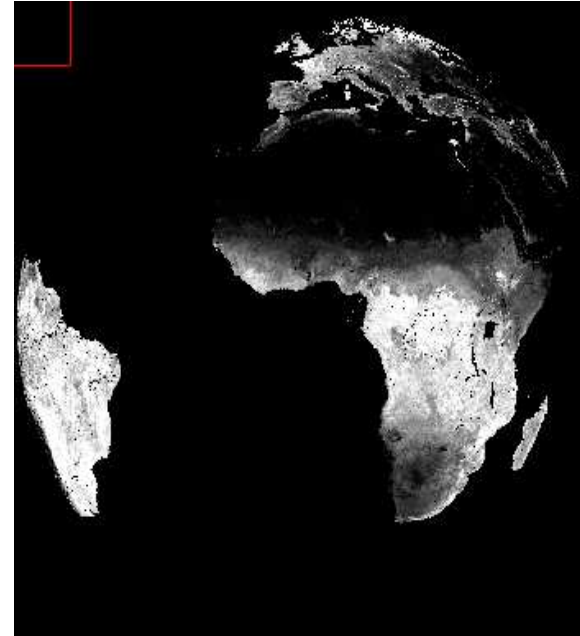
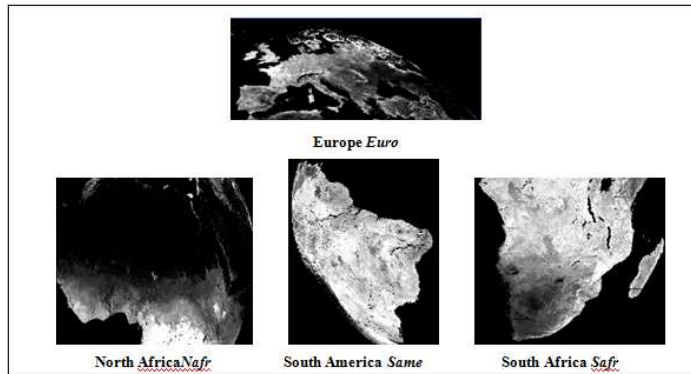
Methods (FVC)

- Mosaicking and reprojection of FVC from MSG-SEVIRI
- Deriving FVC from NDVI of SPOT-VEGETATION
- Comparison of data at same temporal compositing period (10 days)
- Analysis of temporal profiles (daily data) from MSG-SEVIRI for several land-use/land-cover test areas (GLC-2000)



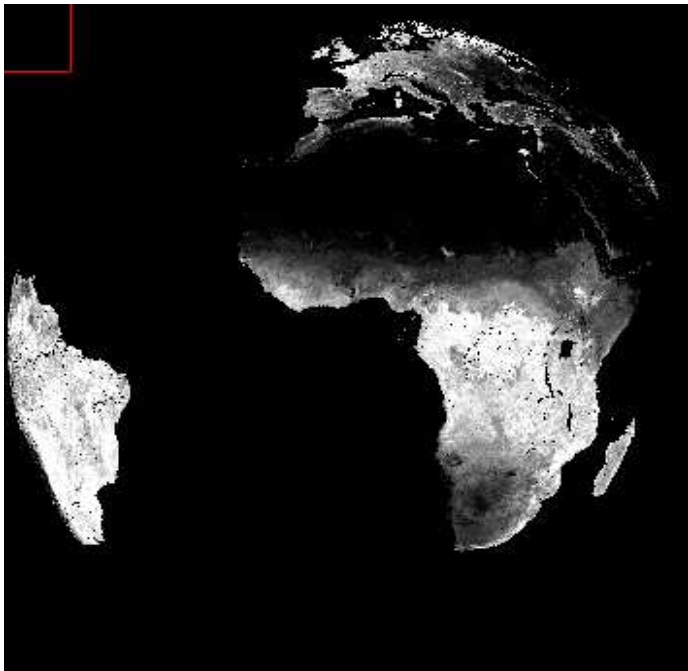
Methods (FVC from MSG-SEVIRI)

- Mosaic of 4 images

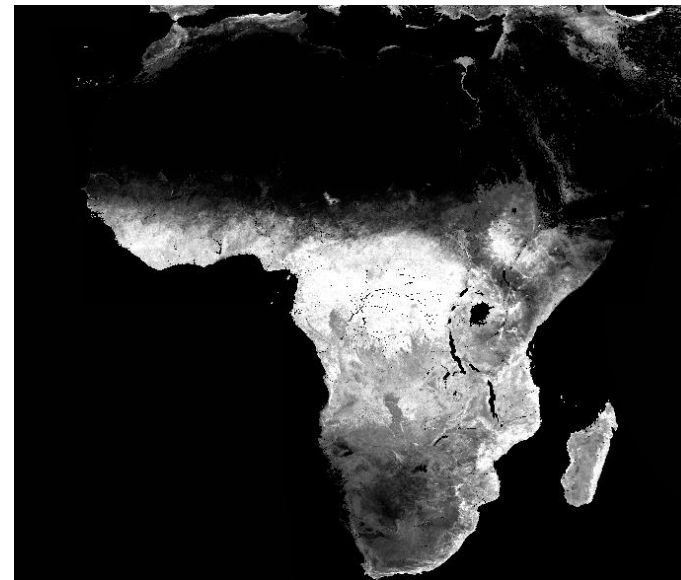


Methods (FVC from MSG-SEVIRI)

- Reprojection in Plate carrée, extraction of African continent and resampling at 0.025°



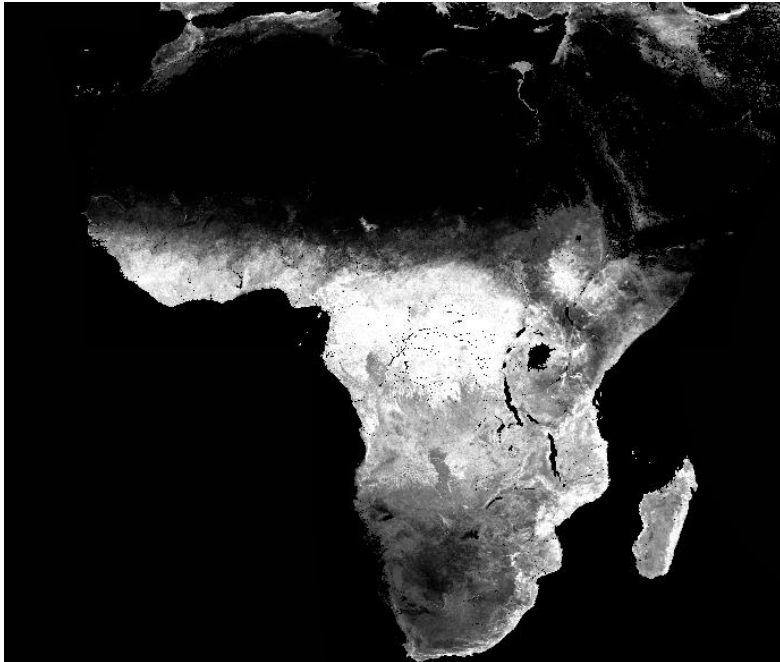
3712 x 3712 pixels



3440 x 2920 pixels

Methods (FVC from MSG-SEVIRI)

- extraction of West Africa area and resampling at 0.05°
- Analysis of daily variations of FVC and computation of median value for 10 days



1000 x 500 pixels

Methods (FVC from SPOT-VEGETATION)

Vegetation indices and empirical approaches

Scaled NDVI: $NDVI^* = \frac{NDVI - NDVI_0}{NDVI_{max} - NDVI_0}$ (NDVI₀: soil, NDVI_{max}: vegetation)

Gutman & Ignatov (1998): $FVC = NDVI^*$

Carlson & Ripley (1997): $FVC = NDVI^{*2}$

Carlson, T. N., & Ripley, D. A. (1997). On the relation between NDVI, fractional vegetation cover, and leaf area index, *Remote Sensing of Environment*, 62, 241-252.

Gutman, G., & Ignatov, A. (1998). The derivation of the green vegetation fraction from NOAA/AVHRR data for use in numerical weather prediction models, *International Journal of Remote Sensing*, 19(8), 1533-1543.



Methods (FVC from SPOT-VEGETATION)

Adapted from BARTHOLOME *et al.*, 2002

- $$FVC = \frac{NDVI - NDVI_{soil}}{NDVI_{max} - NDVI_{soil}}$$
- $NDVI_{max} = 0.85$
- $NDVI_{soil} = 0.10$ (*perennial vegetation cover, cloud-contaminated pixels*) or per pixel adjustment procedure using temporal NDVI profile (36 dekadal values) (*ephemeral vegetation, deserts*)



Methods (FVC from SPOT-VEGETATION)

■ Per pixel adjustment procedure to derive $NDVI_{soil}$ from temporal profile (36 dekadal values) :

pixels with all 36 NDVI values < 0.20 (deserts)

$NDVI_{soil}$ defined as median of 36 values

pixels with at least 15 NDVI values < 0.20 (ephemeral vegetation cover)

$NDVI_{soil}$ defined as minimum of these values below threshold

pixels with 1 to 14 NDVI values < 0.20 (cloud-contaminated pixels)

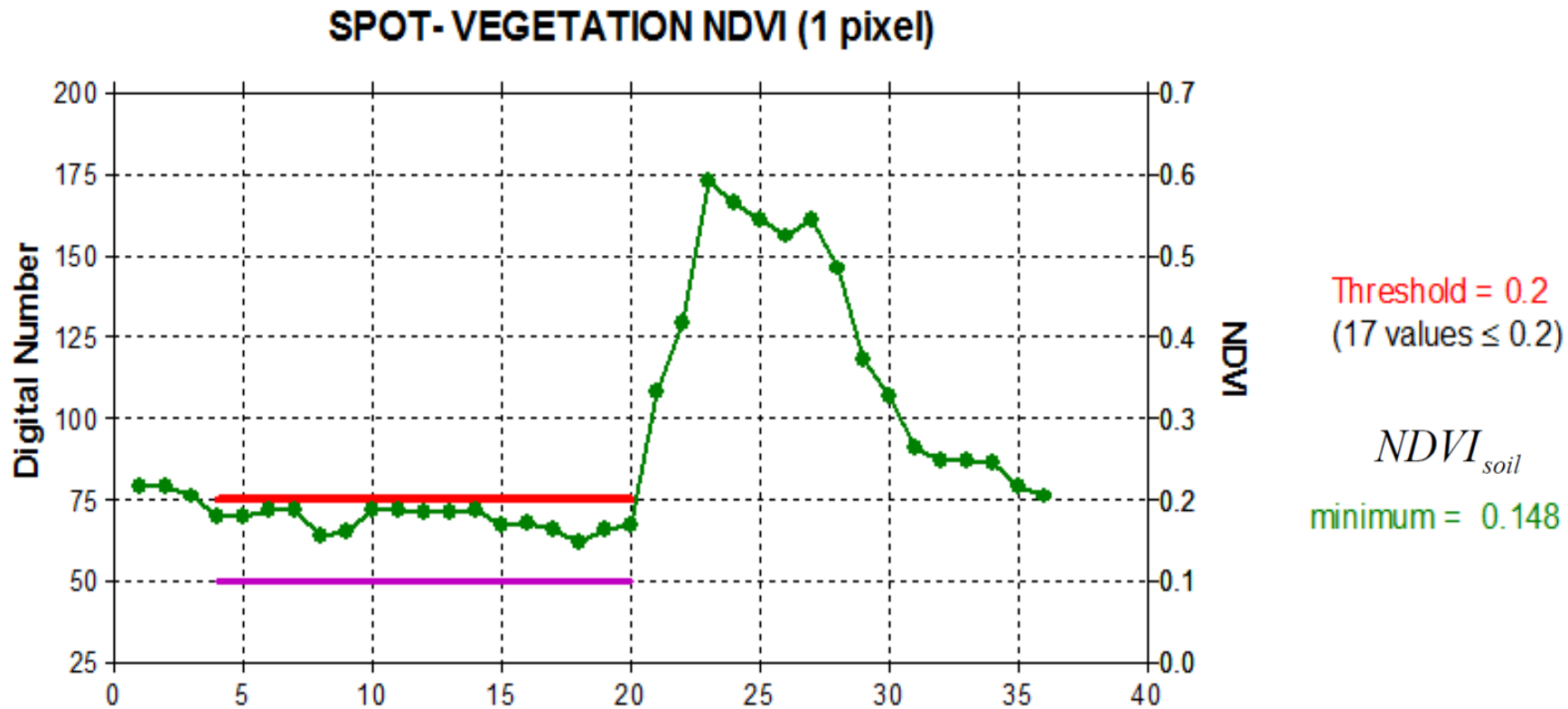
$NDVI_{soil} = 0.10$

pixels with all 36 NDVI values > 0.20 (perennial vegetation cover)

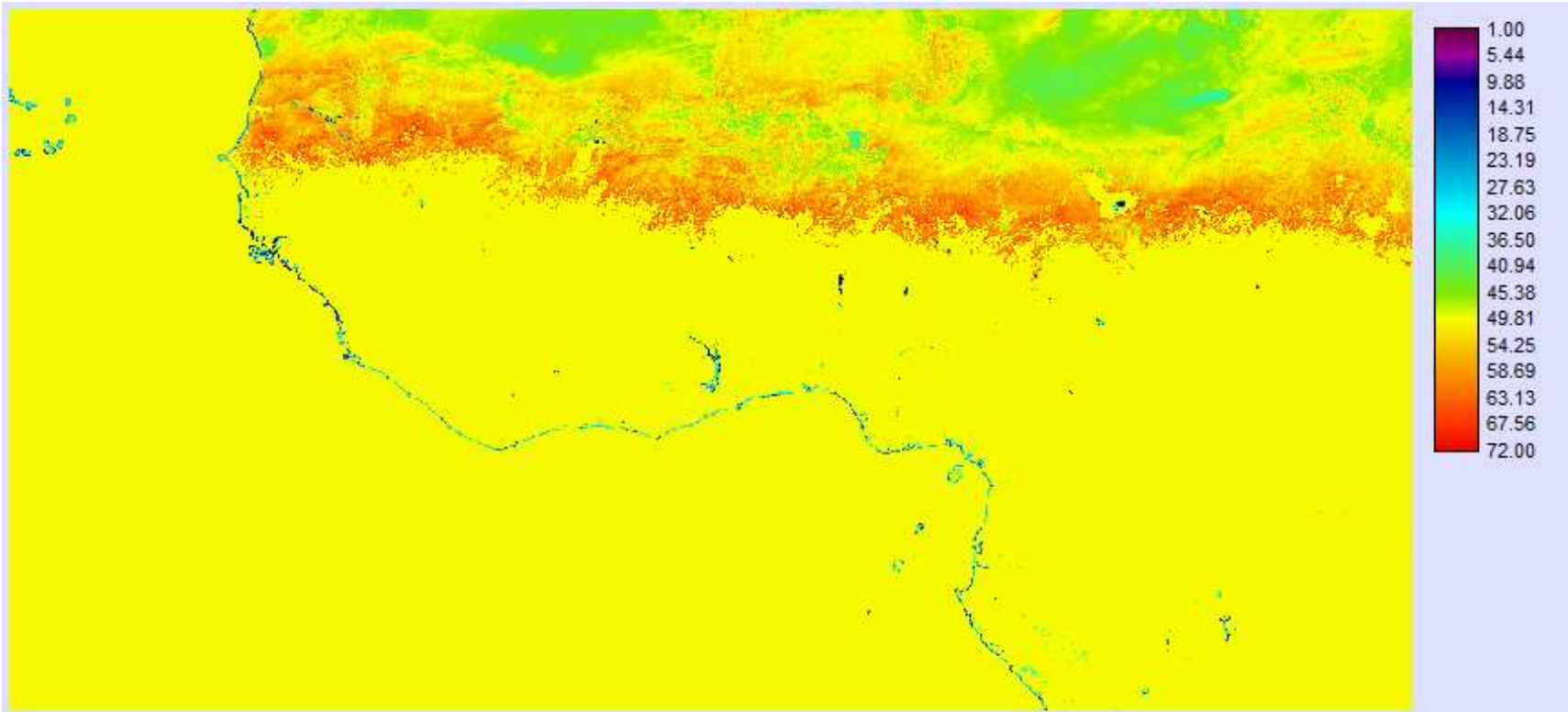
$NDVI_{soil} = 0.10$



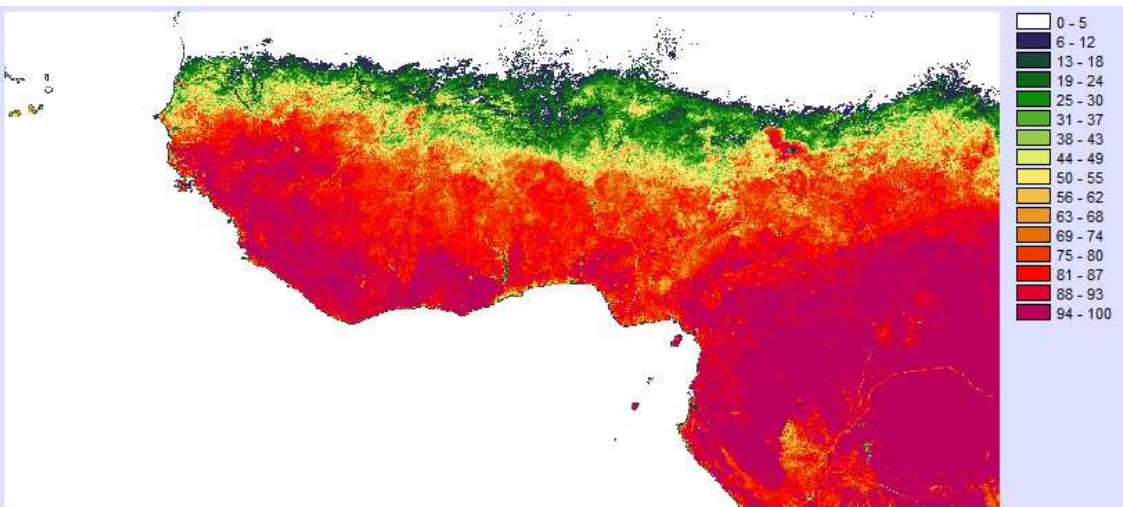
Methods (FVC from SPOT-VEGETATION)



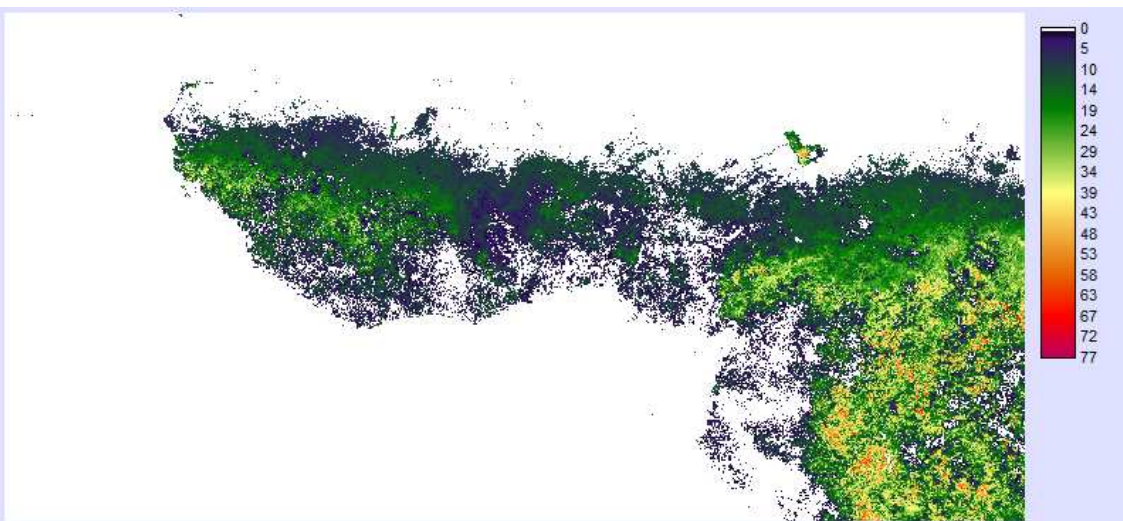
Bare soil NDVI offset correction



FVC from SPOT-VEGETATION



Year 2007 Maximum FVC

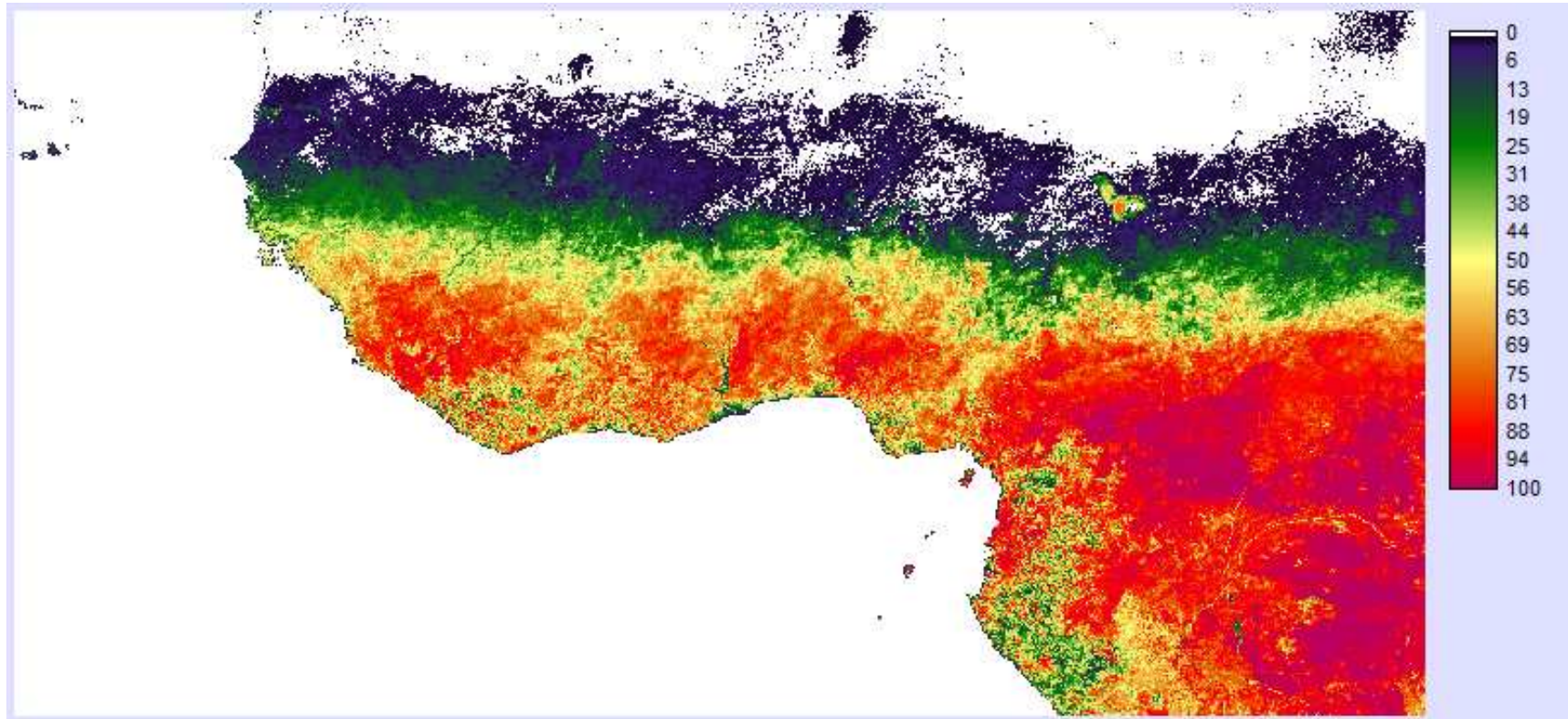


Year 2007 Minimum FVC



FVC from SPOT-VEGETATION

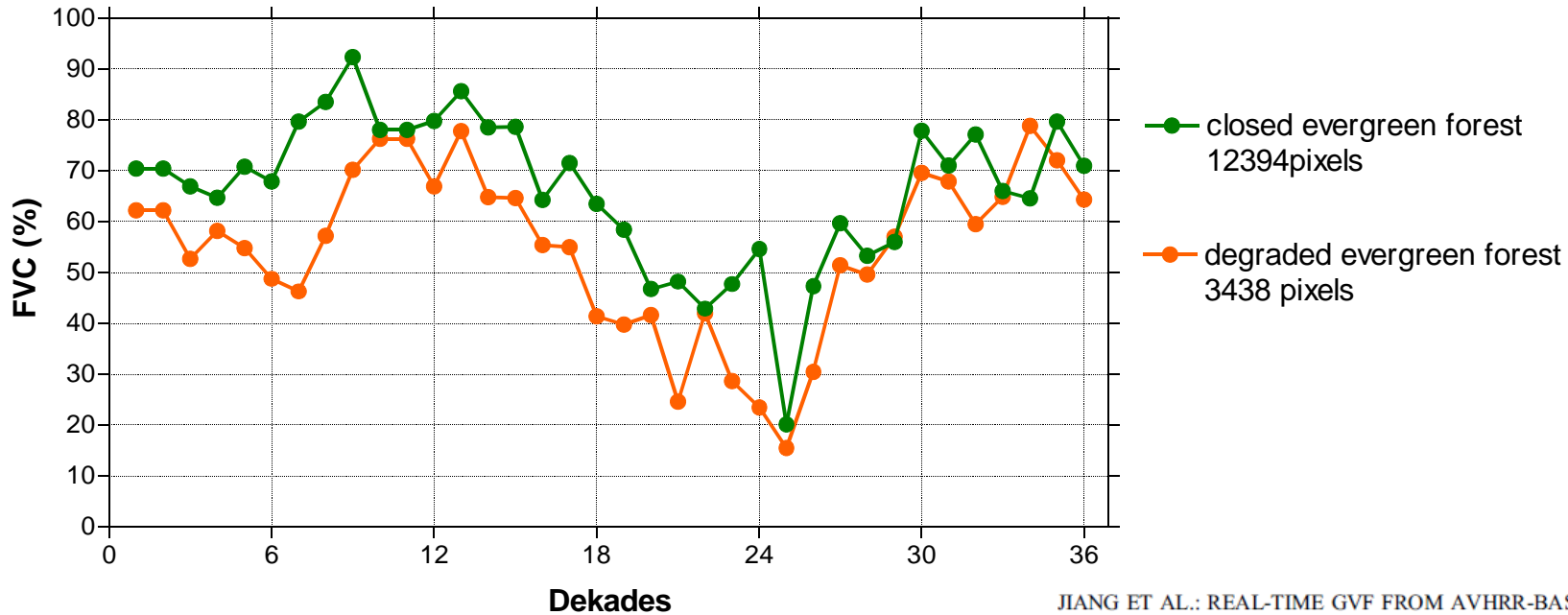
21-31 may 2007- Fraction of Vegetation Cover (%)



Temporal profile of FVC

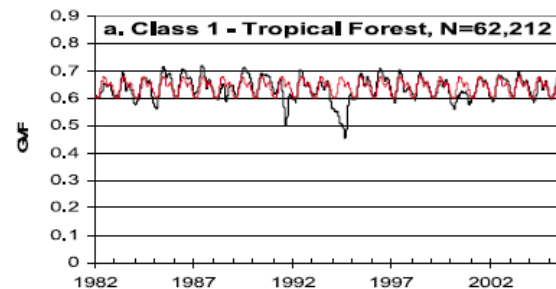
YEAR 2007

SPOT-VEGETATION



JIANG ET AL.: REAL-TIME GVF FROM AVHRR-BASED NOAA GVI
J. of Geophysical Research (2010)

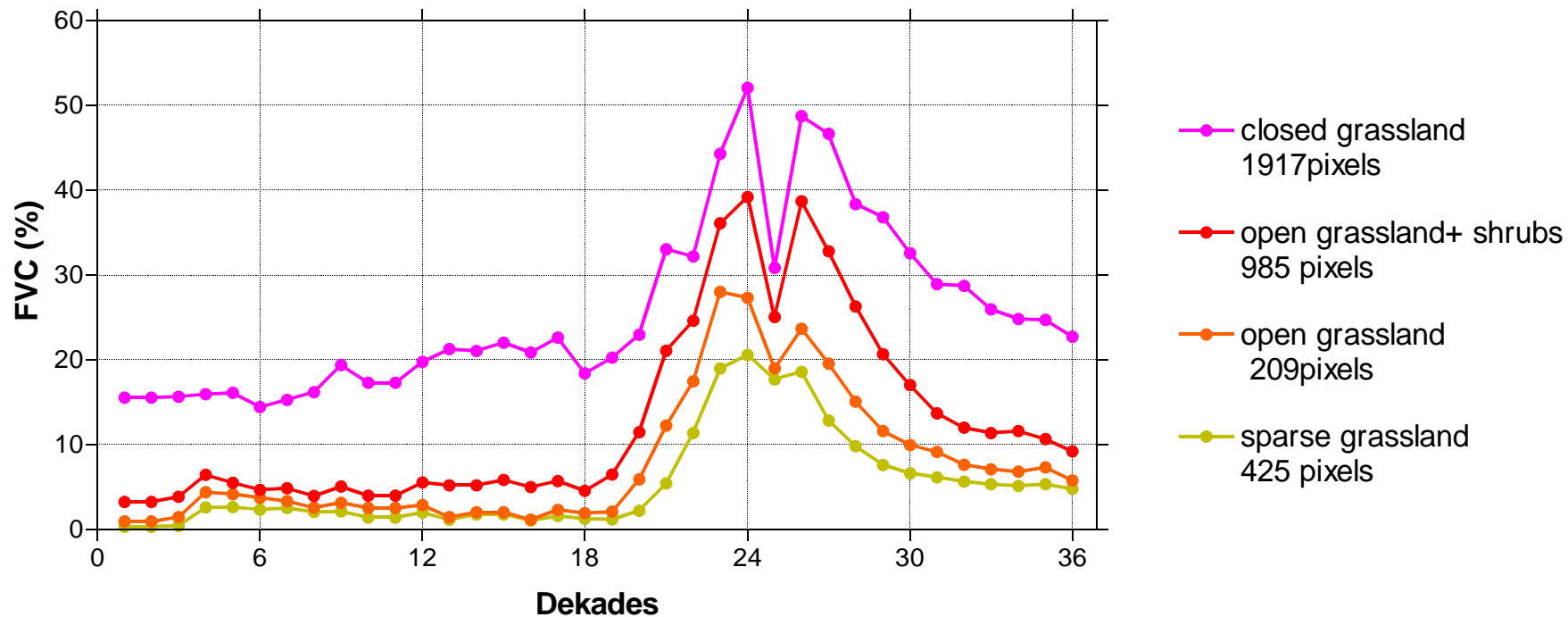
NOAA-AVHRR (GVF)



Temporal profile of FVC

SPOT-VEGETATION

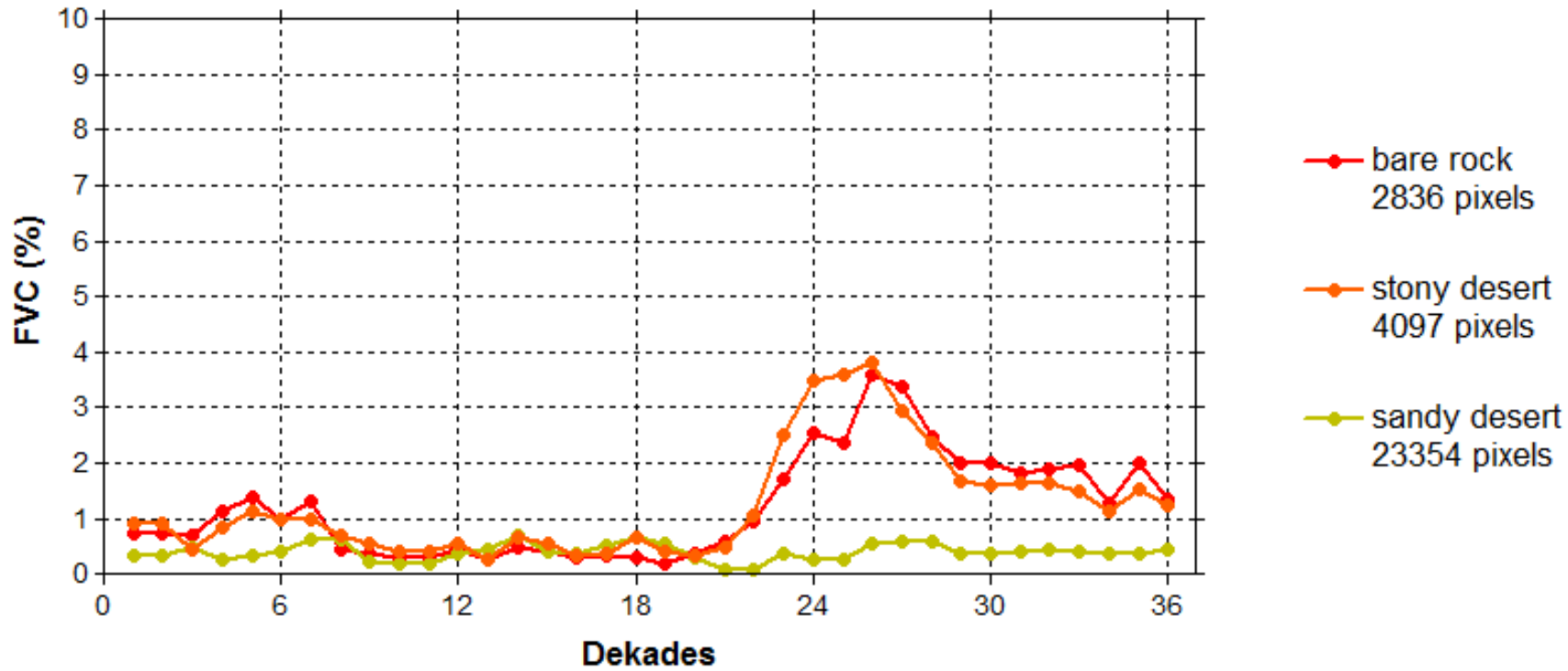
YEAR 2007



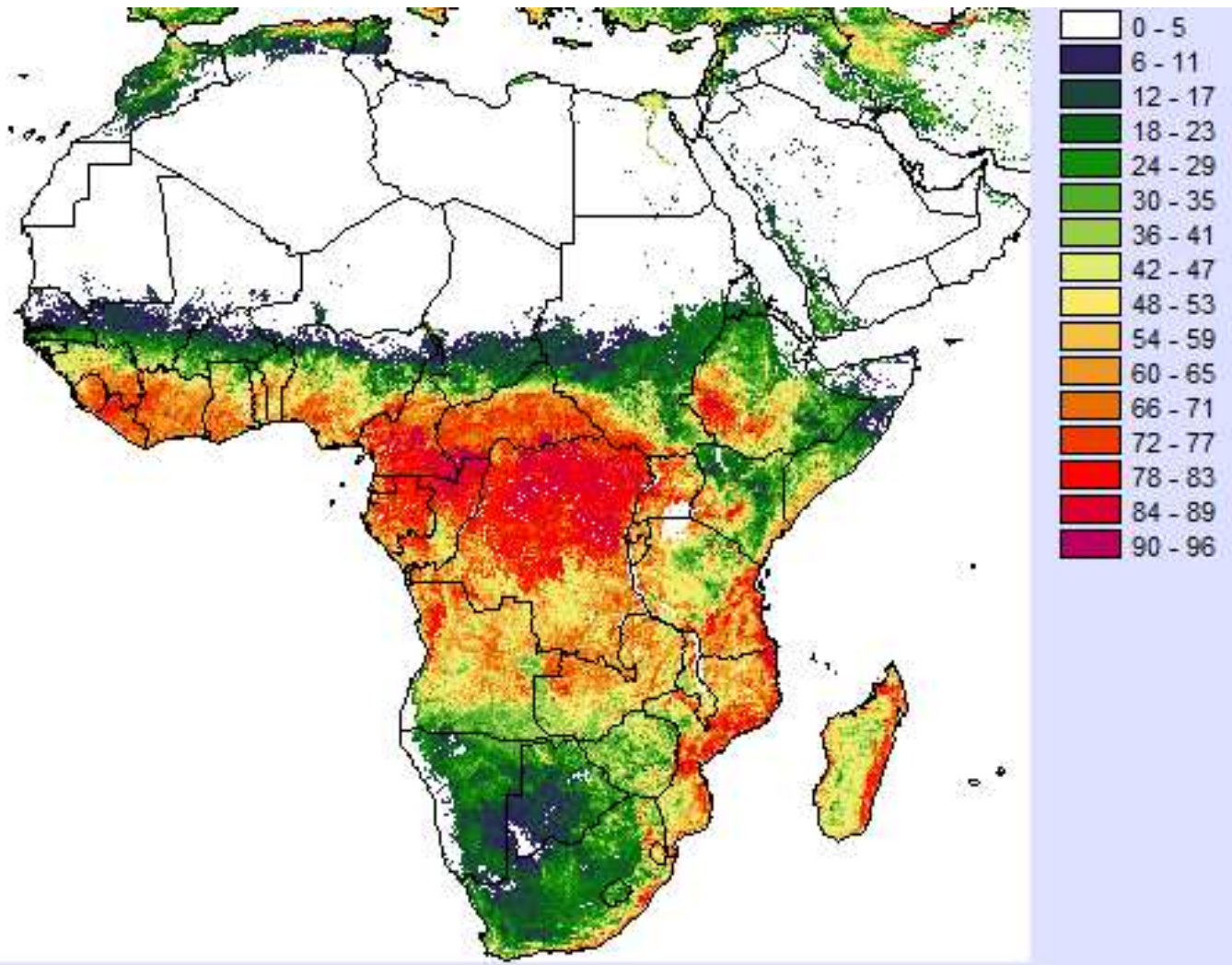
Temporal profile of FVC

SPOT-VEGETATION

YEAR 2007

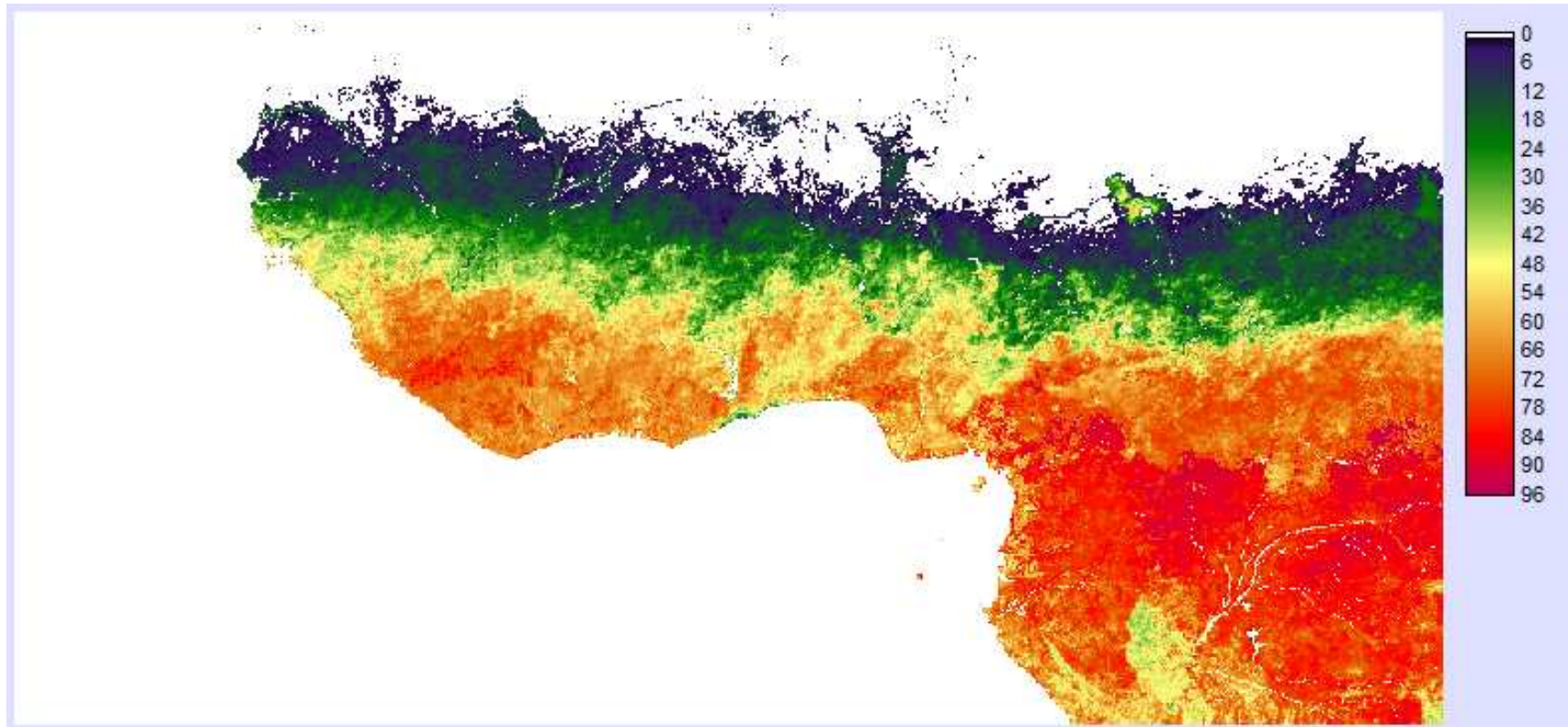


FVC from MSG-SEVIRI 21-31 may 2007



FVC from MSG-SEVIRI

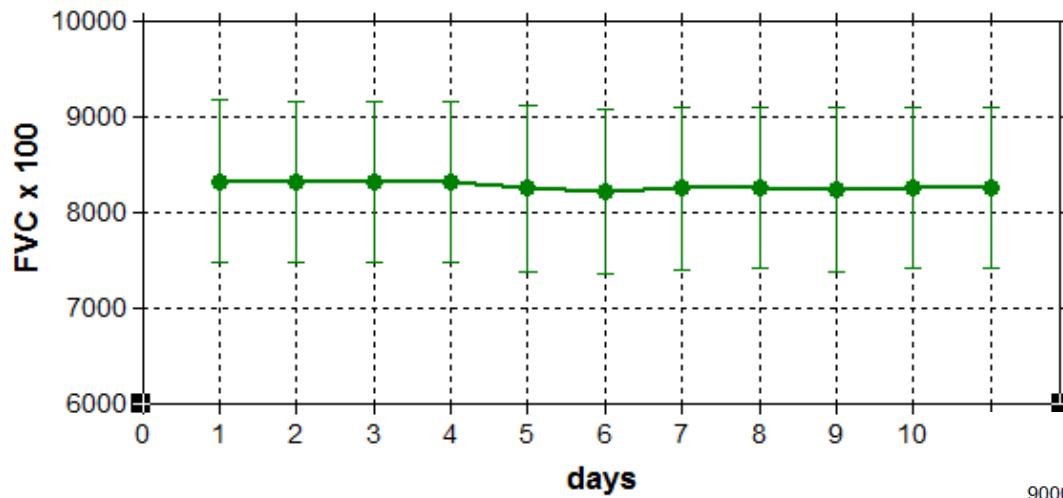
21-31 may 2007- Fraction of Vegetation Cover (%)



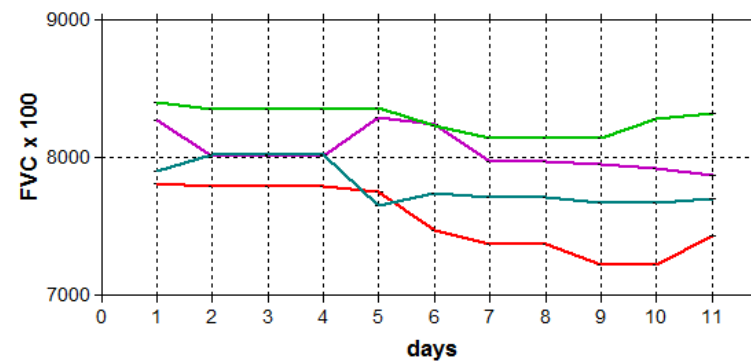
Daily values of FVC 21-31 May 2007

MSG-SEVIRI

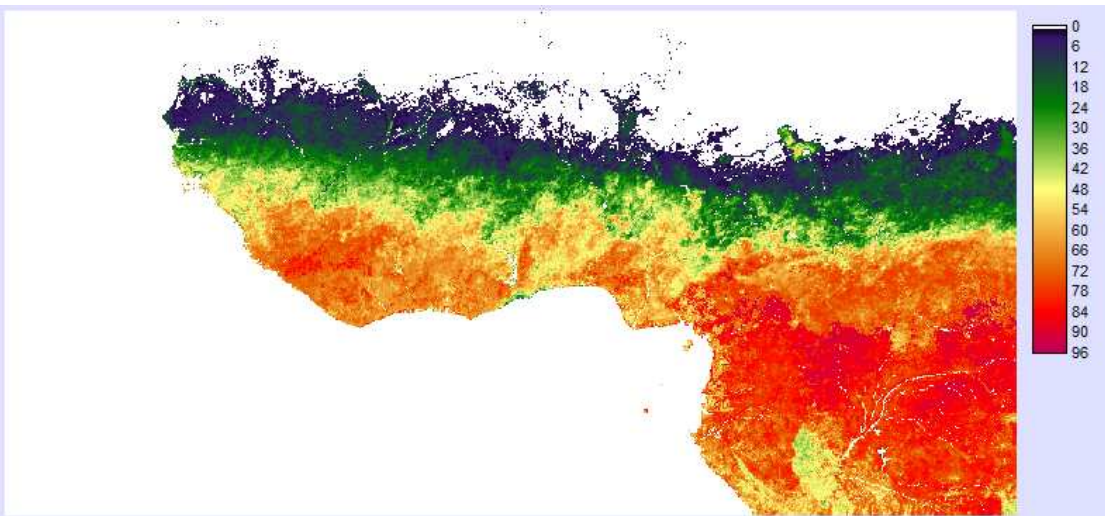
closed evergreen forest
(5810 pixels)



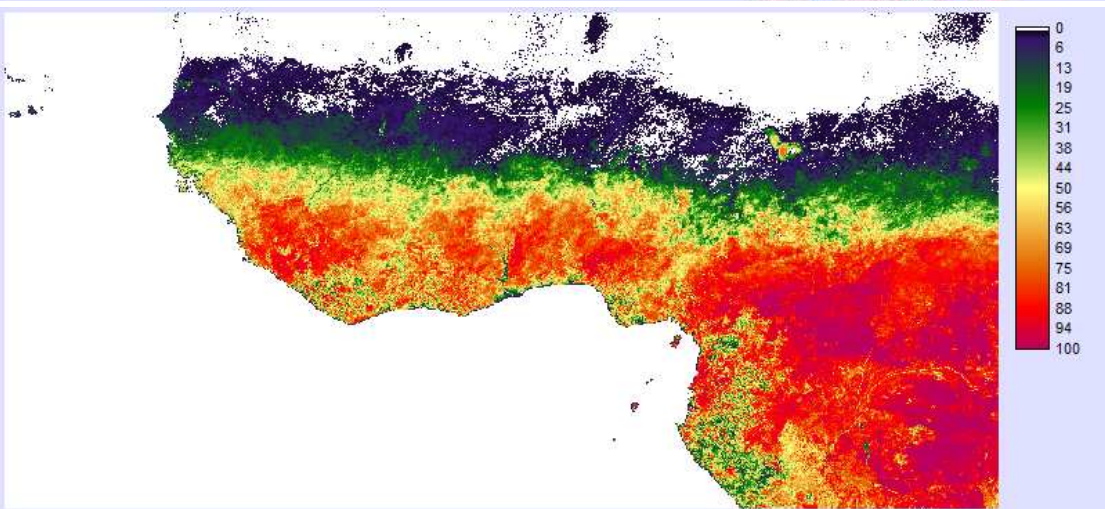
individual pixels



Comparison of FVCs 21-31 may 2007



MSG-SEVIRI



SPOT-VEGETATION

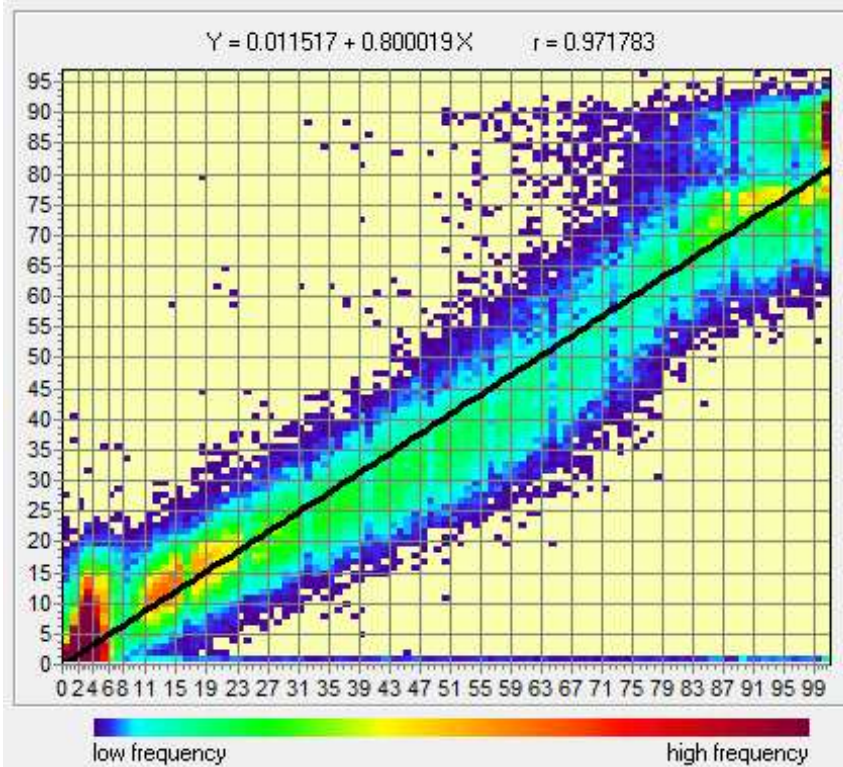
Regression between FVCs

(cloud-free pixels only)

$$Y = 0.01 + 0.8 X$$

$$r^2 = 0.94$$

MSG-SEVIRI



Regression Parameters:

X axis: 2007_05_21_FVC
Y axis: FVC_moyenne21-31mai2007

Coeff. of Det.	=	94.44 %
Std. Dev. of X	=	35.117669
Std. Dev. of Y	=	28.910558
S.E. of Estimate	=	6.819312
Std. Error of Beta	=	0.000535
t Stat for r or Beta	=	1493.985916
t Stat for Beta <> 1	=	-373.452808
Sample Size (n)	=	131501
Apparent df	=	131499

SPOT-VEGETATION



Conclusions of FVC comparison

- A biophysical measurement like FVC is better than an index like NDVI
- FVCs from MSG-SEVIRI and from SPOT-VEGETATION, although obtained through different approaches are highly correlated in cloud-free areas; investigations still needed to elucidate the difference in absolute values (about 20%) and in-depth comparison of seasonal and inter-annual trends
- Further inter-comparisons should be done with other sensors (AVHRR, MODIS, METOP, etc.) and need of validation of FVC estimates from high spatial resolution images and ground measurements



Questions

- Gaps in the data archive of FVC...?
- Archive of FVC data before march 2007?
- Why not a full-disc image of FVC?
- Availability of 10 days and monthly FVCs?
- Availability of daily spectral albedos in 3 solar reflective channels?



Last, but not least... FVC should be called GVF

Fraction of Vegetation Cover is different from **Green Vegetation Fraction**. The former is a description of how “green” a land pixel is when seen from space. The latter just tells the fraction of the pixel that is occupied by vegetation, regardless whether such vegetation is green (e.g., full growth) or not green (e.g., partial growth or dormant).



Invitation to participate... CNRS GDRI on MSG applications to environmental monitoring

- Project of implementing an international research network GDRI, to be submitted to CNRS in may 2011
- Topic: multidisciplinary applications of MSG data for near-real time monitoring (geography, plant ecology, geology, epidemiology, natural hazards, etc.)
- If project accepted, CNRS funding available for meetings, exchanges, etc. (not for research)
contact: lacaze.bernard@gmail.com



Thank you for attention

