EUMETRAIN

Event Week on Heatwaves and Droughts

29 May to 1 June 2023 - ONLINE

LSA SAF Vegetation products

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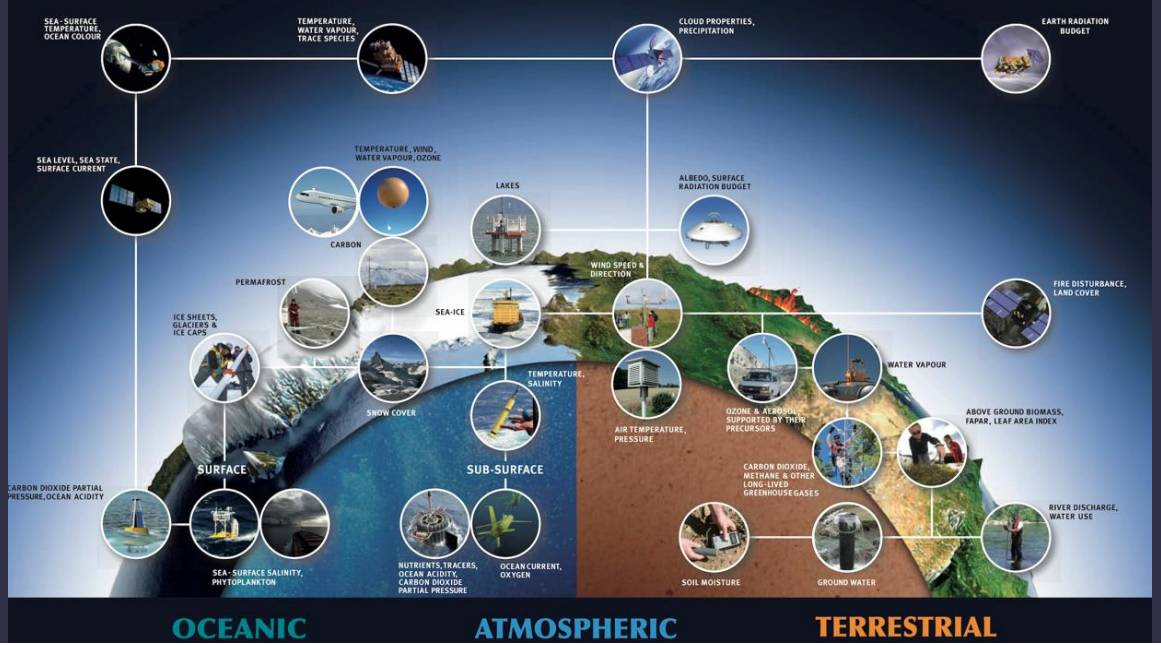
VNIVERSITAT DE VALÈNCIA

UV ERS

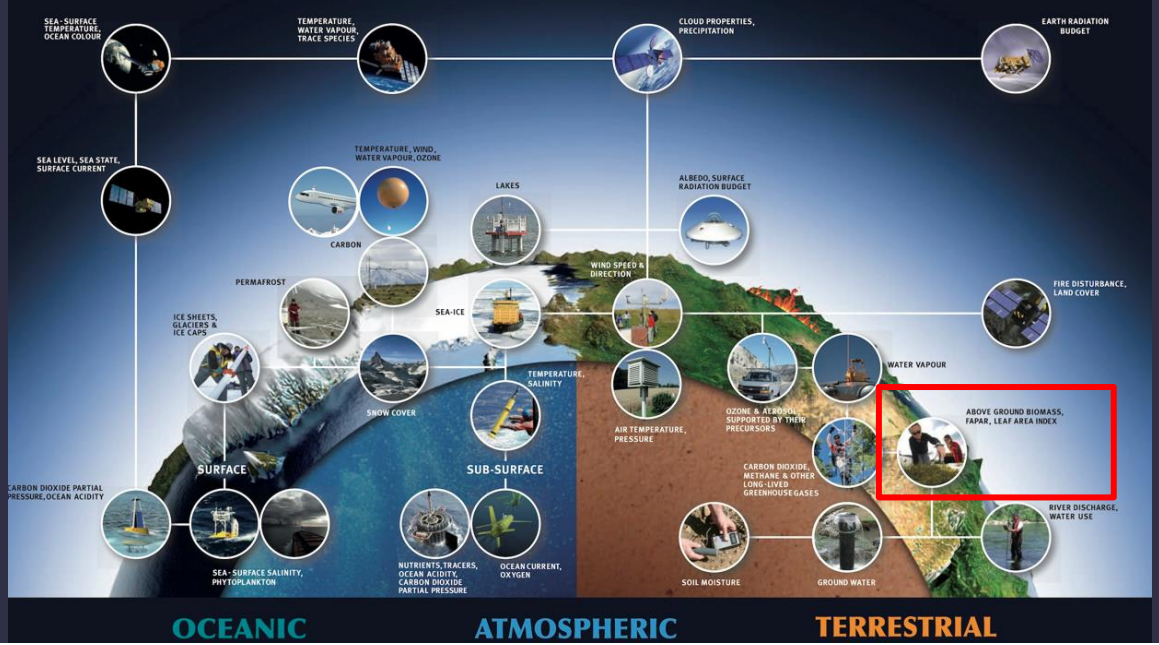
Roadmap

ECV



Essential Climate Variables

Necessity of an improved monitoring of the global climate system → Essential Climate Variables (ECVs) defined formally in 2003.



Essential Climate Variables

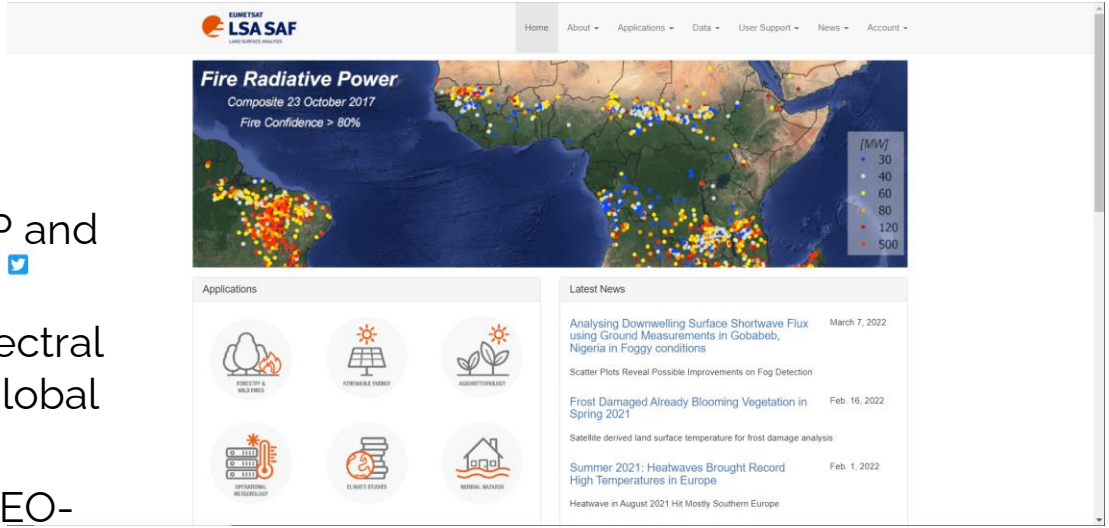
An ECV is a physical, chemical or biological variable or a group of linked variables that critically contributes to the characterization of Earth' s climate.

Amount of available sensors → increase the access to a complete portofolio of ECVs from EO data.

Roadmap

LSA SAF VEGA PRODUCTS

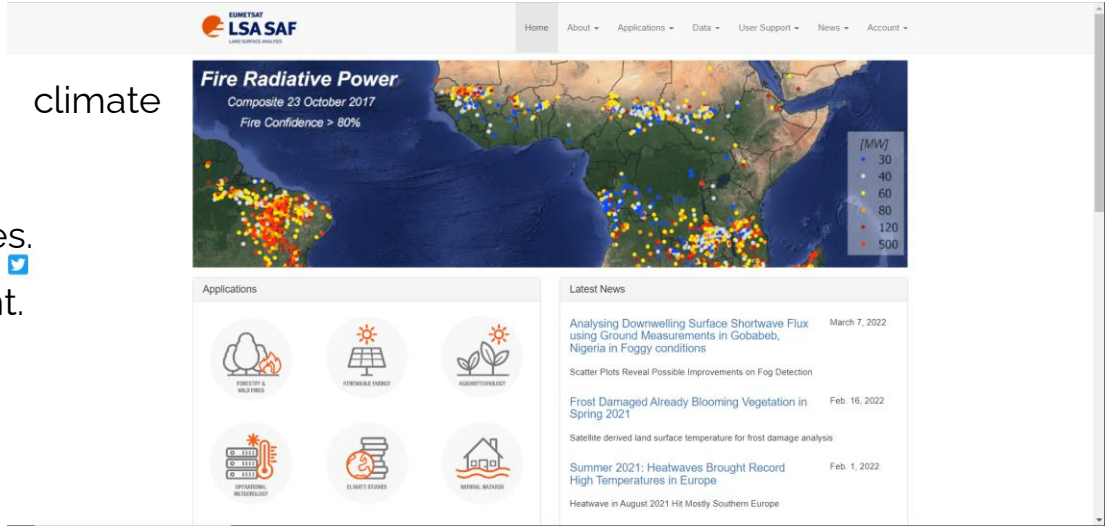
- **Estimates** of LAI, FAPAR, FVC, GPP and CWC.
- **Simulation** of vegetation cover spectral signatures by means of a RTM at global scale.
- **Comparison** between operational EO-based biophysical products.



https://landsaf.ipma.pt/en/

LSA SAF VEGA PRODUCTS

- Numerical Weather prediction and climate modelling.
- Monitoring terrestrial ecosystem processes.
- Environmental monitoring and assessment.
- Carbon and Energy fluxes modelling.
- Agricultural and forest applications.
- Climate analysis.



https://landsaf.ipma.pt/en/

LSA SAF VEGA PRODUCTS

SEVIRI/MSG

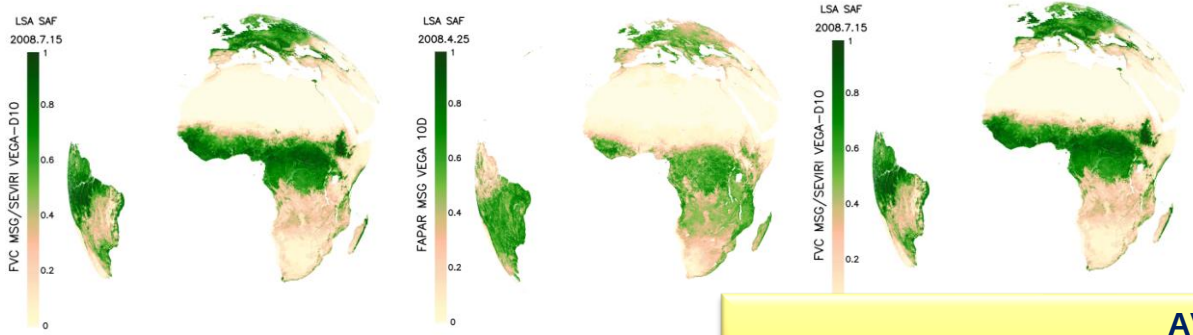
Vegetation products

VEGA daily &

10-daily: Operational since 2008

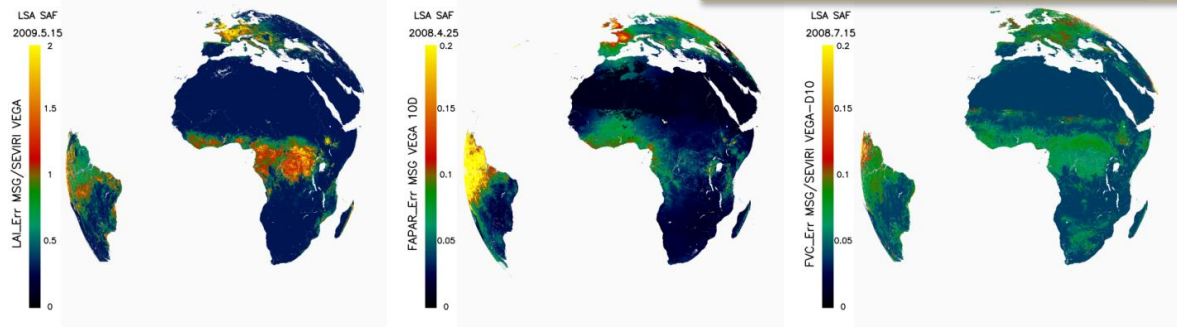
LAI **FAPAR** **FVC**

Product field



AVAILABLE
CLIMATIC DATA RECORDS (2004-2015)

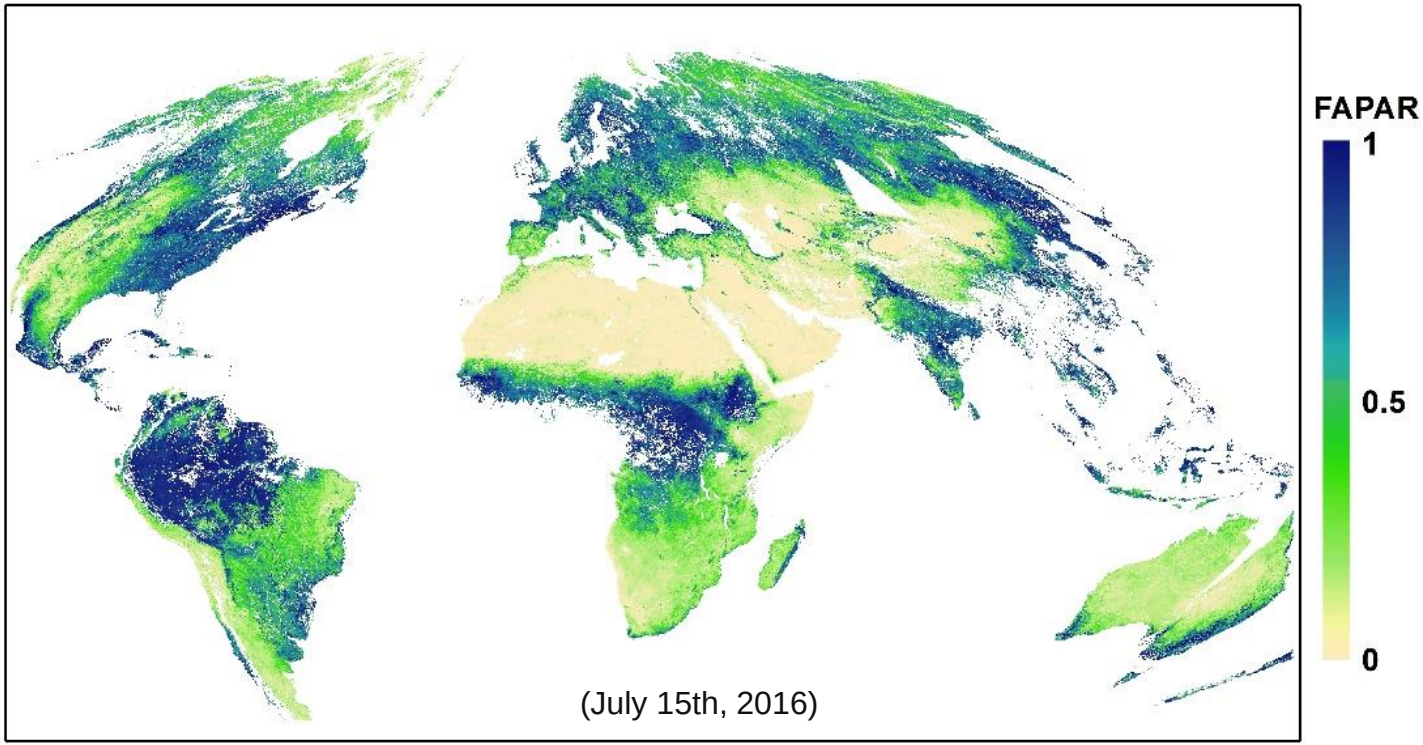
Error estimates



LSA SAF VEGA PRODUCTS

AVHRR/Metop
1 km

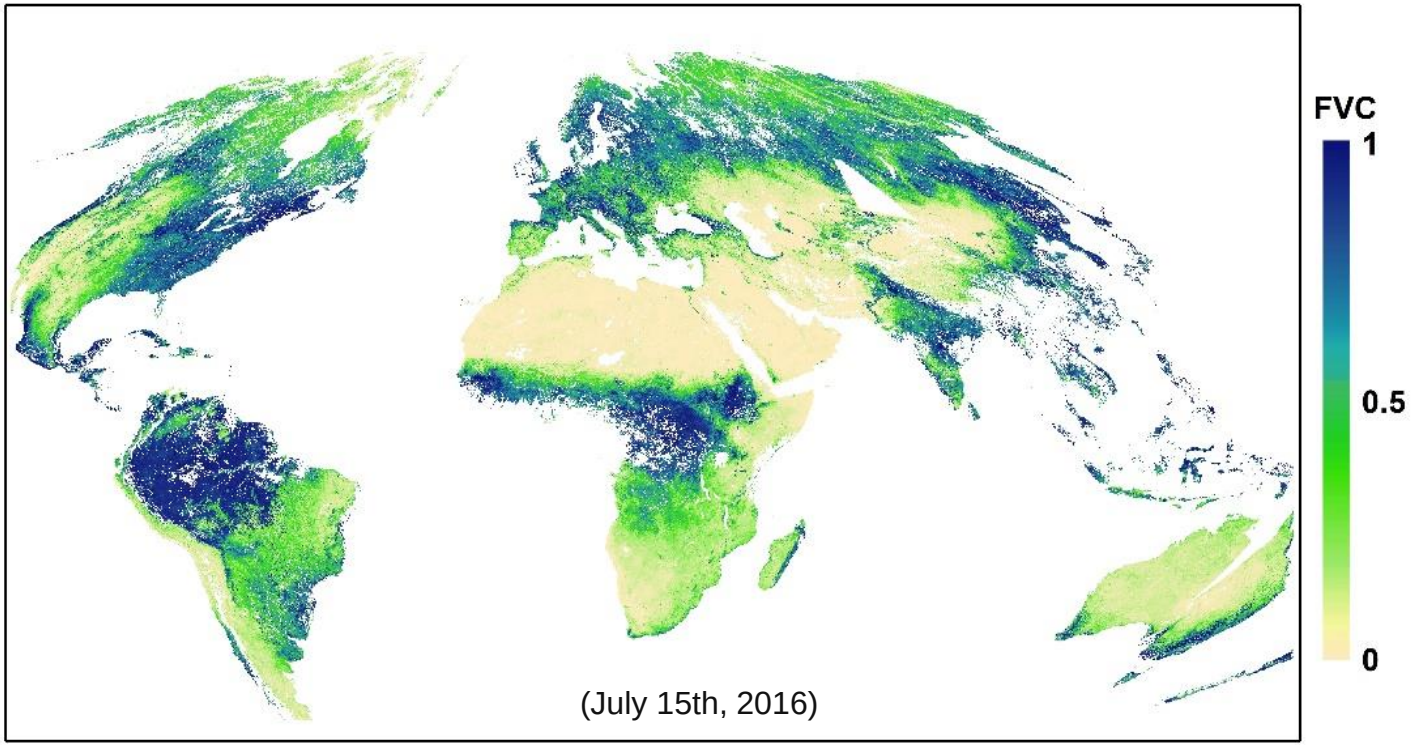
0.01˚ x 0.01˚
Since 2015

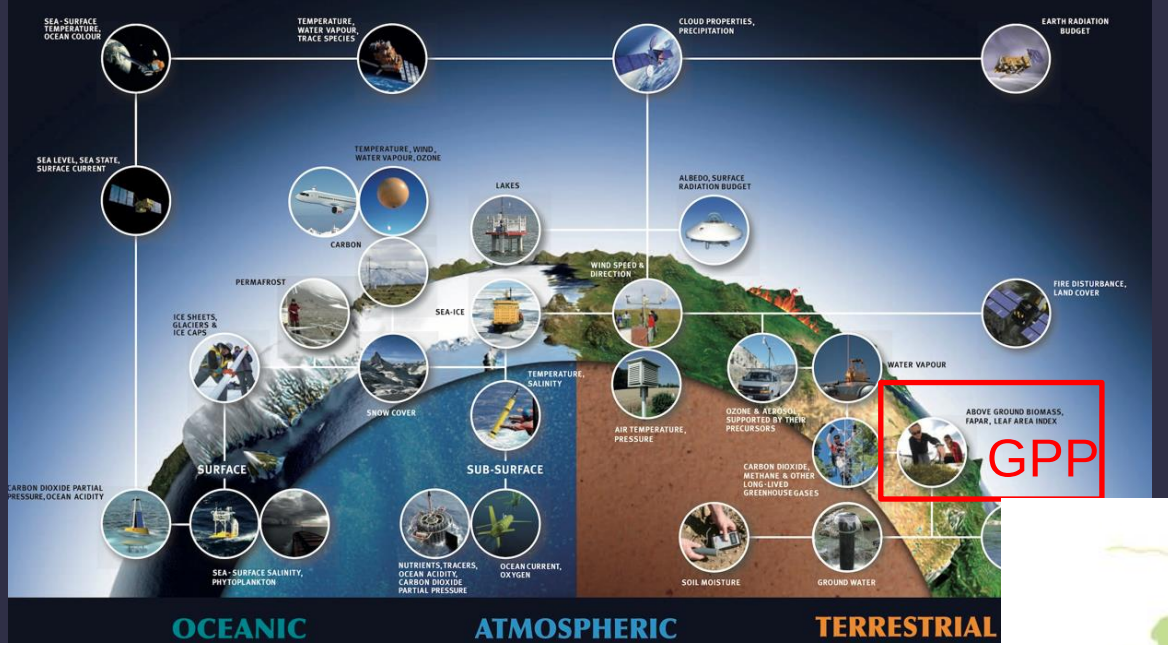


LSA SAF VEGA PRODUCTS

AVHRR/Metop
1 km

0.01˚ x 0.01˚
Since 2015

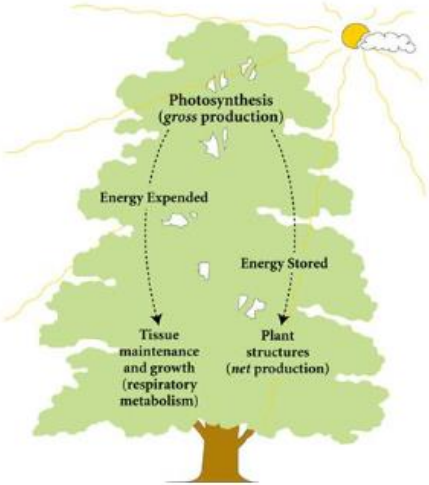




UV-ERS: Research lines

GPP measures the atmospheric carbon uptake per unit photosynthesis.

Essential parameter to characterize the ecosystem processe

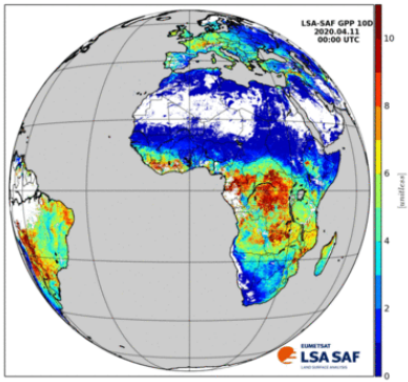


GPP

EUMETSAT LSA SAF LAND SURFACE ANALYSIS

Home | About | Applications | Data | User Support | News

MSG 10-days Gross Primary Production (MGPP, LSA-411)



Example of Product

NRT Product available since Mar 2018

GET DATA HERE

The **gross primary production (GPP)**, i.e. the rate at which vegetation converts light into chemical energy by photosynthesis, is an essential parameter to characterize the ecosystem processes. The assessment of GPP on wide areas, which is necessary to study the global carbon cycle and for planning and managing resources in response to changing environmental conditions, can be performed using procedures driven by remote sensing data.

Product Documentation

This operational product is documented in the following documents:

- **Product User Manual (PUM)**
- **Product Output Format (POF)**
- **Validation Report (VR)**
- **Algorithm Theoretical Basis Document (ATBD)**
- **Algorithm Changes Record**

Please see Product Peer-Review publications in References.

Acknowledgements

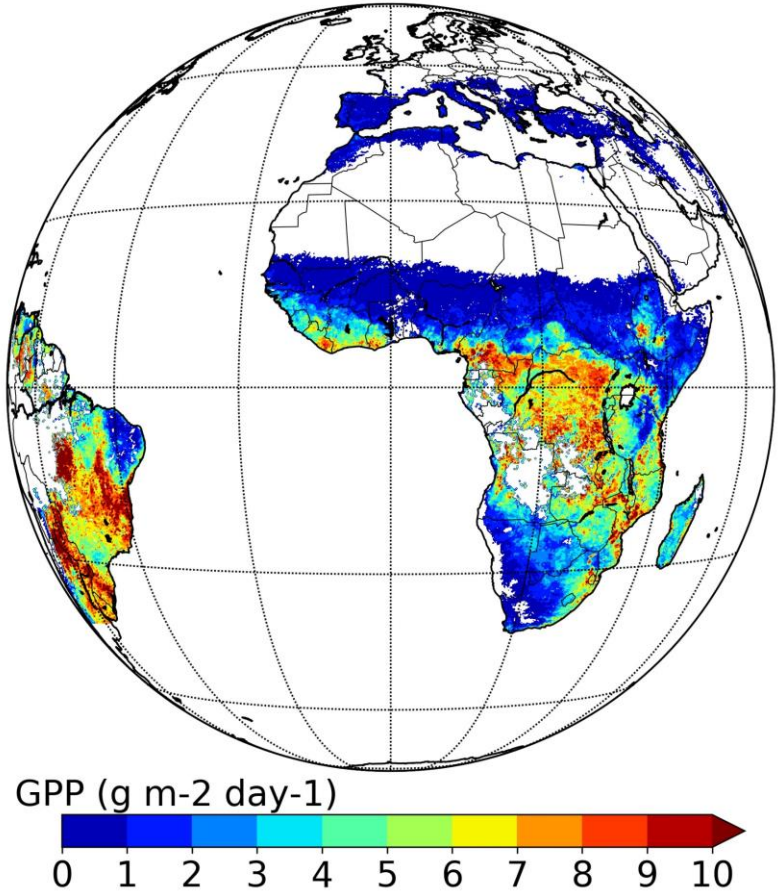
More info on this product at https://landsaf.ipma.pt/en/products/vegetation/mgpp/

GPP

- **GLOBAL SCALE:**

(LSA SAF)

- Near real time production of **10-day GPP.**
- **(MGPP LSA-411)**
- Operationally disseminated since March 2018.



GPP

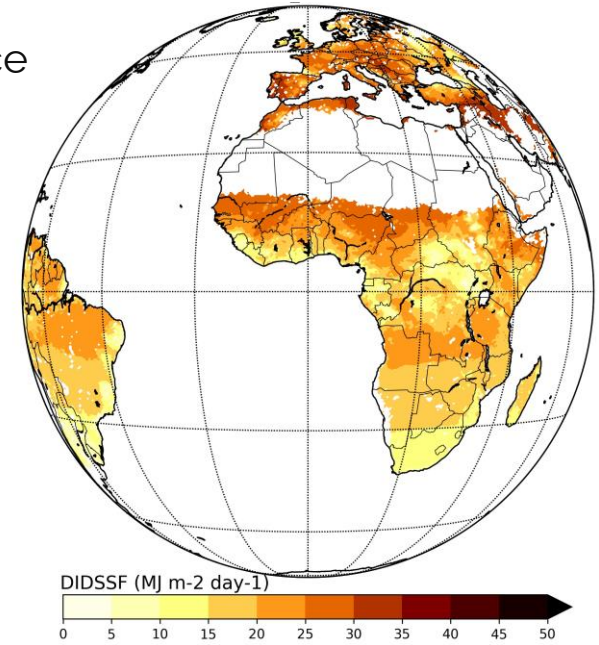
$$\mathbf{GPP} = \varepsilon f_{APAR}(\mathbf{0.46\ DIDSSF})$$

PAR

Incoming photosynthetically active radiation

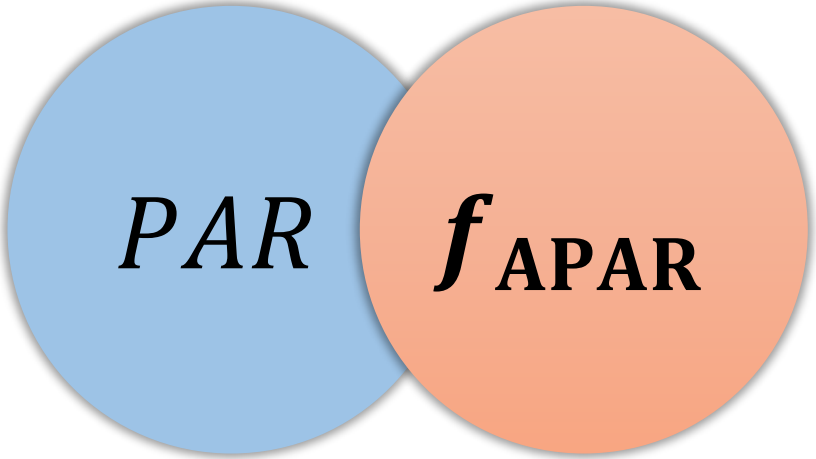
Daily Incoming downwelling Surface shortwave fluxes

DIDSSF (LSA-203)



GPP

$$\mathbf{GPP} = \varepsilon f_{APAR}(0.46\ \mathrm{DIDSSF})$$

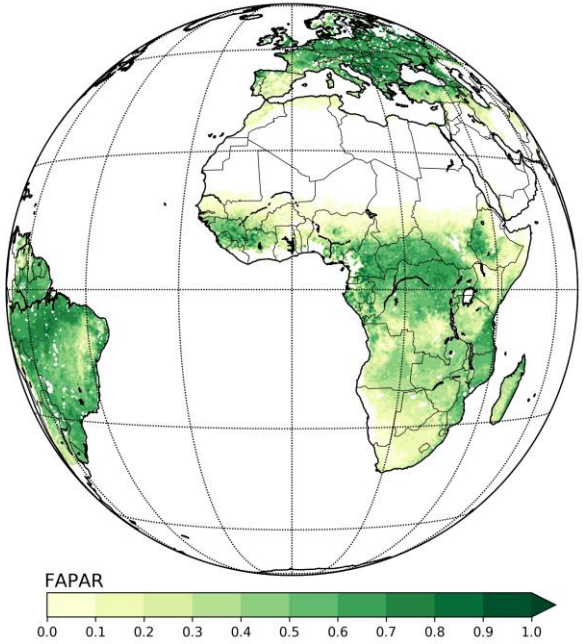


Operational LSA SAF product.

Renormalized Difference Vegetation Index (**RDVI**).

Clear-sky TOC reflectances in the red R and NIR bands for an **optimal angular geometry** in the solar principal plane (Roujean and Bréon, 1995).

MDFAPAR (LSA-425)

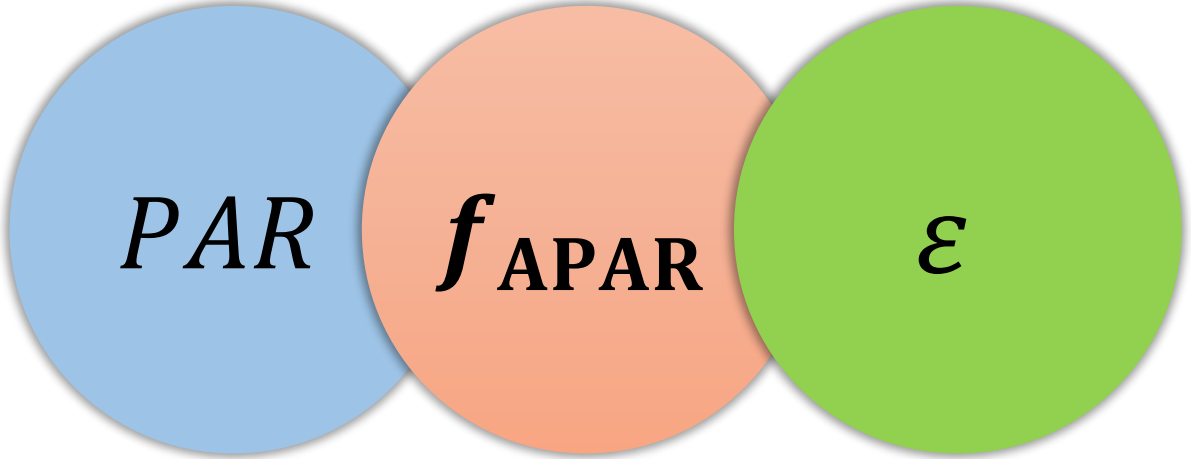


- Fraction of absorbed photosynthetically active radiation

GPP

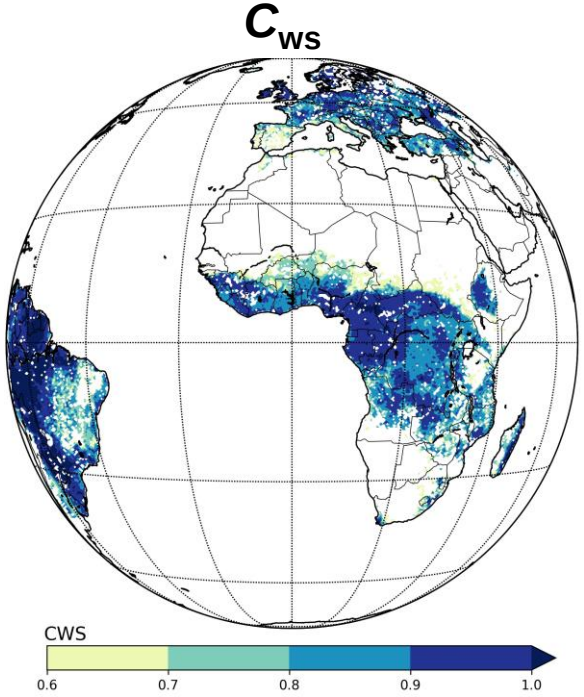
$$\mathbf{GPP} = \varepsilon f_{APAR}(0.46\ \mathrm{DIDSSF})$$

Light use efficiency



$$\varepsilon = \varepsilon_{\max} C_{\mathrm{ws}}$$

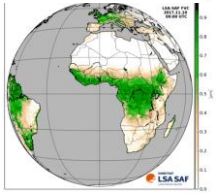
$\varepsilon_{\max}$ → land cover data $\quad C_{\mathrm{ws}} = 0.6 + 0.4\dfrac{\mathrm{DMET}}{\mathrm{DMETREF}}$



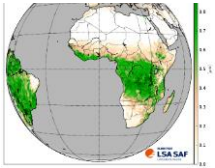
LSA SAF VEGA PRODUCTS

NRT

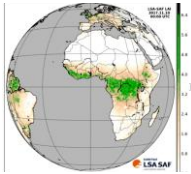
MSG Daily FVC (MDFVC) SAF-421



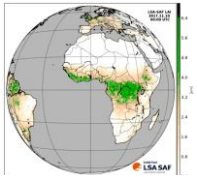
MSG 10-days FVC (MTFVC) SAF-422



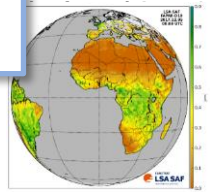
MSG Daily FVC (MTLAI) SAF-423



MSG 10-days LAI (MTLAI) SAF-424

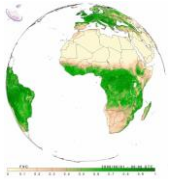


MSG 10-days FAPAR

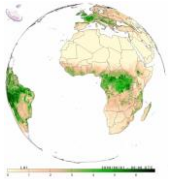


CDRs

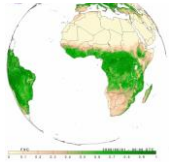
MSG 10-days FVC (MTFVC-R) SAF-50

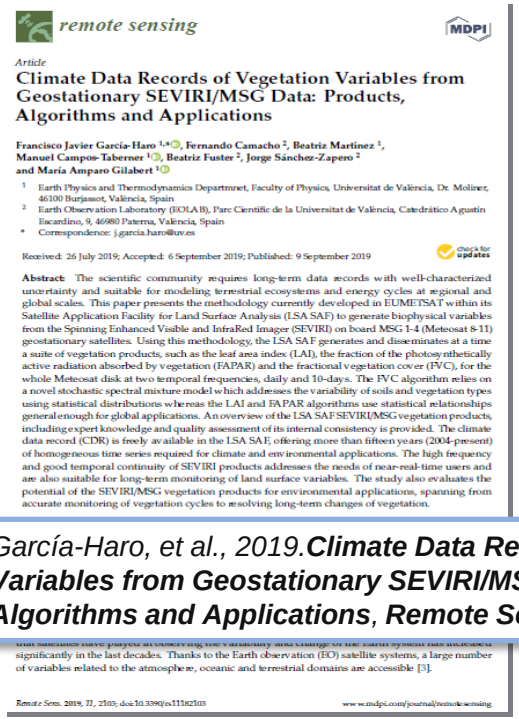


MSG 10-days LAI (MTLAI-R) SAF-451

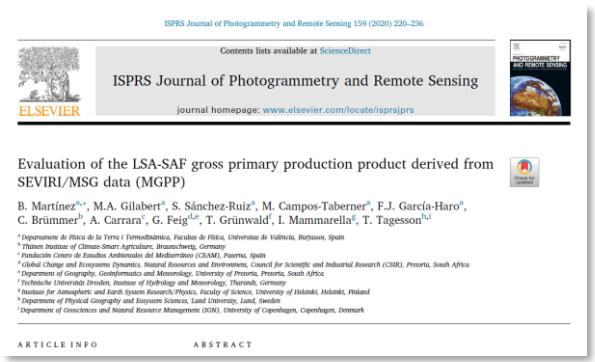


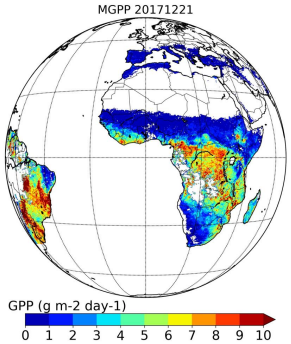
MSG 10-days FAPAR (MTfAPAR-R) SAF-452



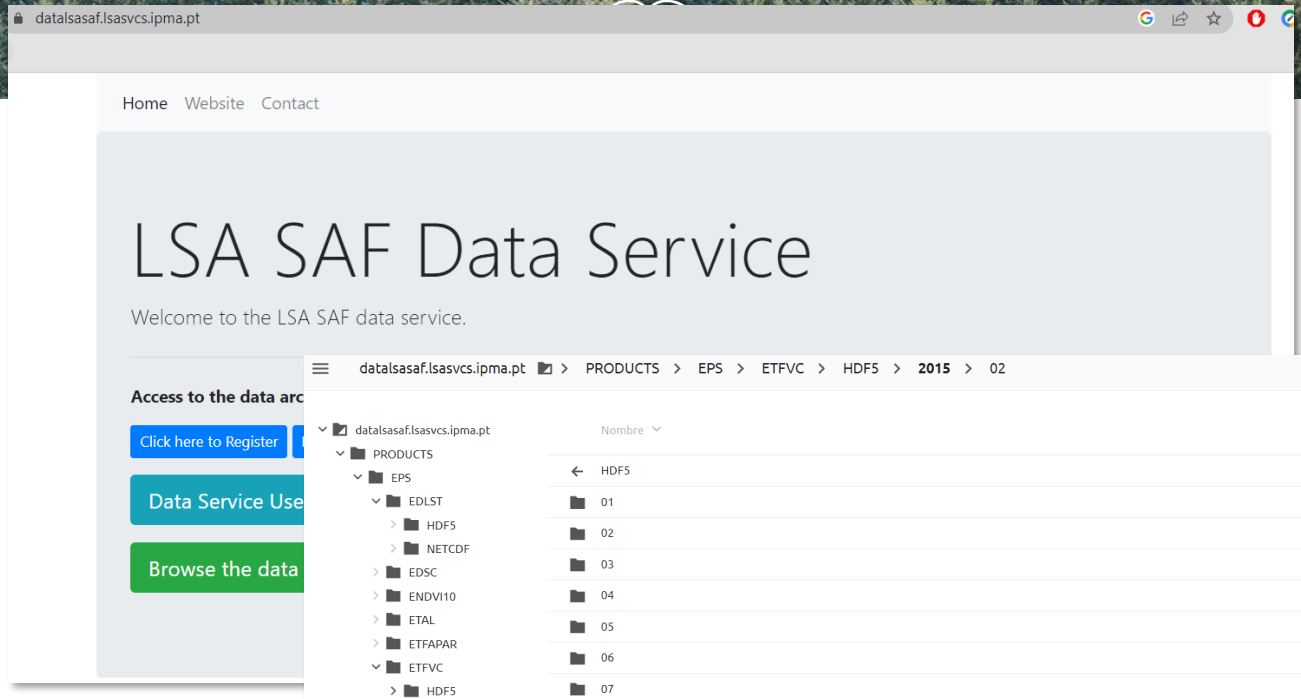


García-Haro, et al., 2019. ***Climate Data Records of Vegetation Variables from Geostationary SEVIRI/MSG Products: Algorithms and Applications***, ***Remote Sensing*** , *11, 2103.*





VEGA DATA ACQUISITION



https://datalsasaf.lsasvcs.ipma.pt/

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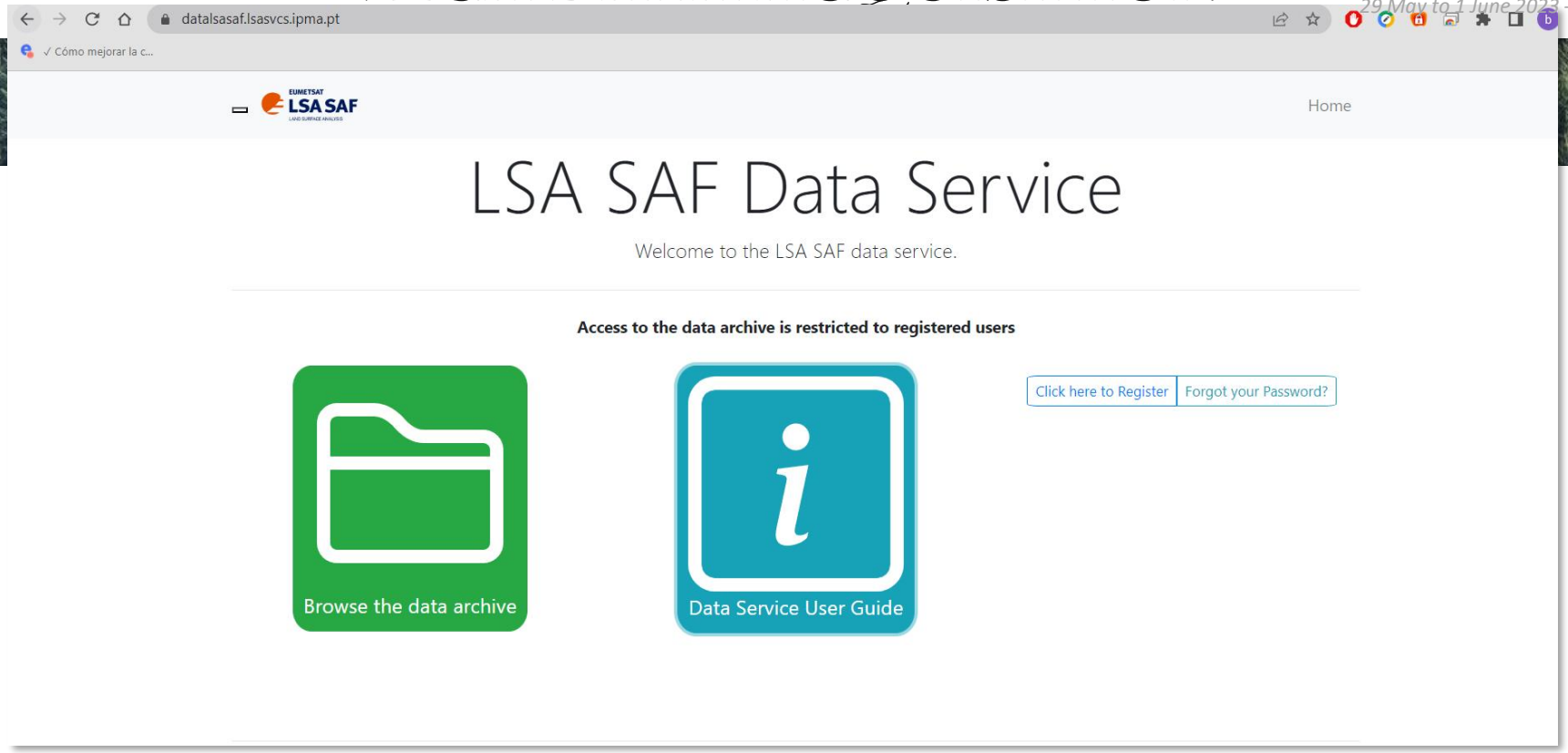

https://gitlab.com/helpdesk.landsaf/lsasaf_data_access/-/tree/main/Readme.md

https://gitlab.com/helpdesk.landsaf/lsasaf_data_access/-/tree/main/examples/webdav/read_map_hdf5_webdav.ipynb


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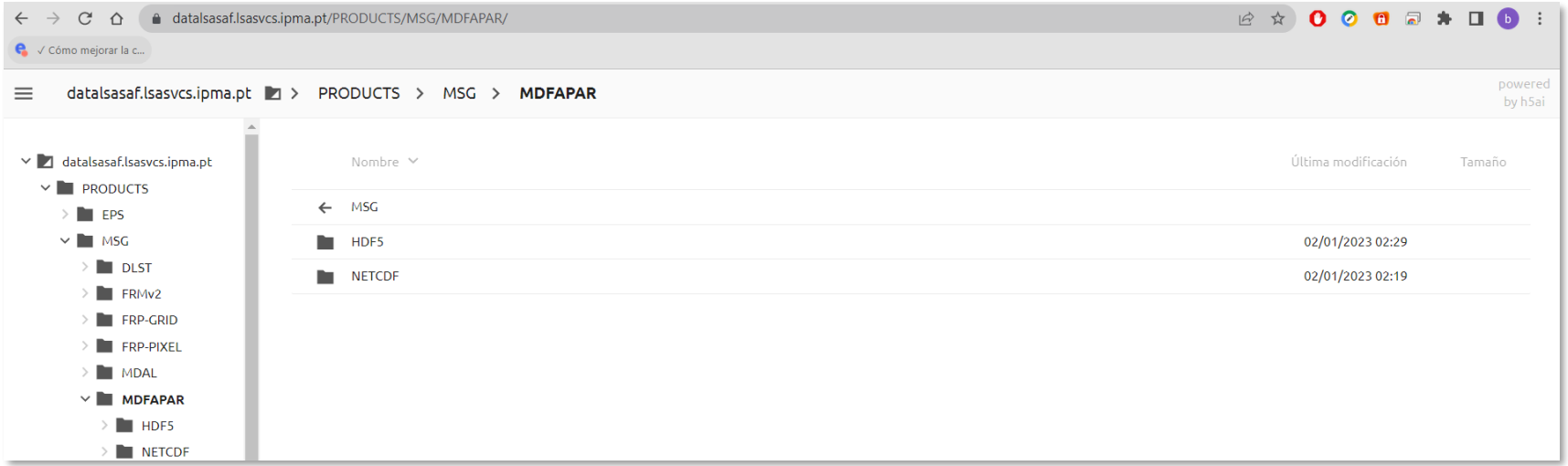
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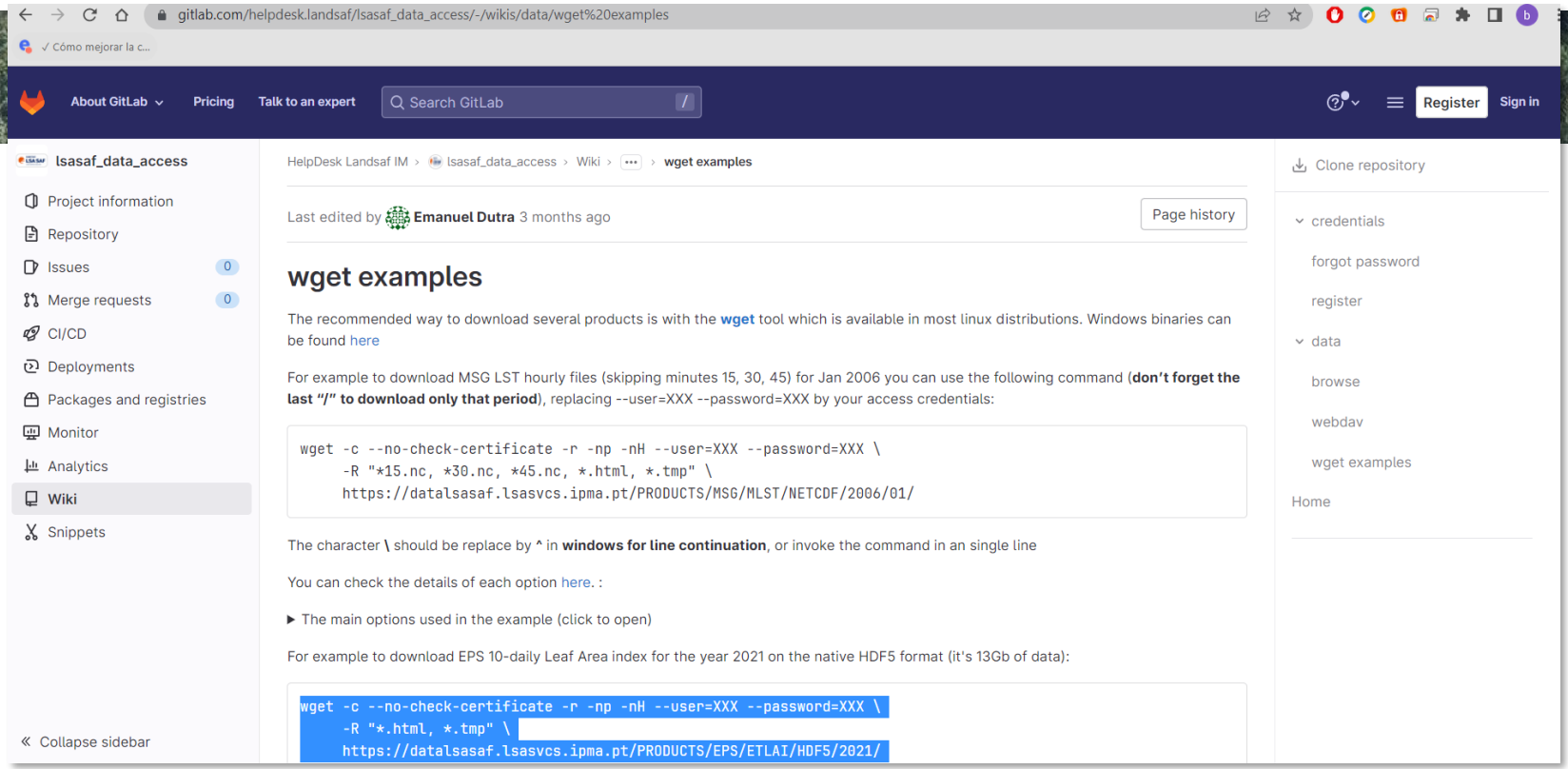

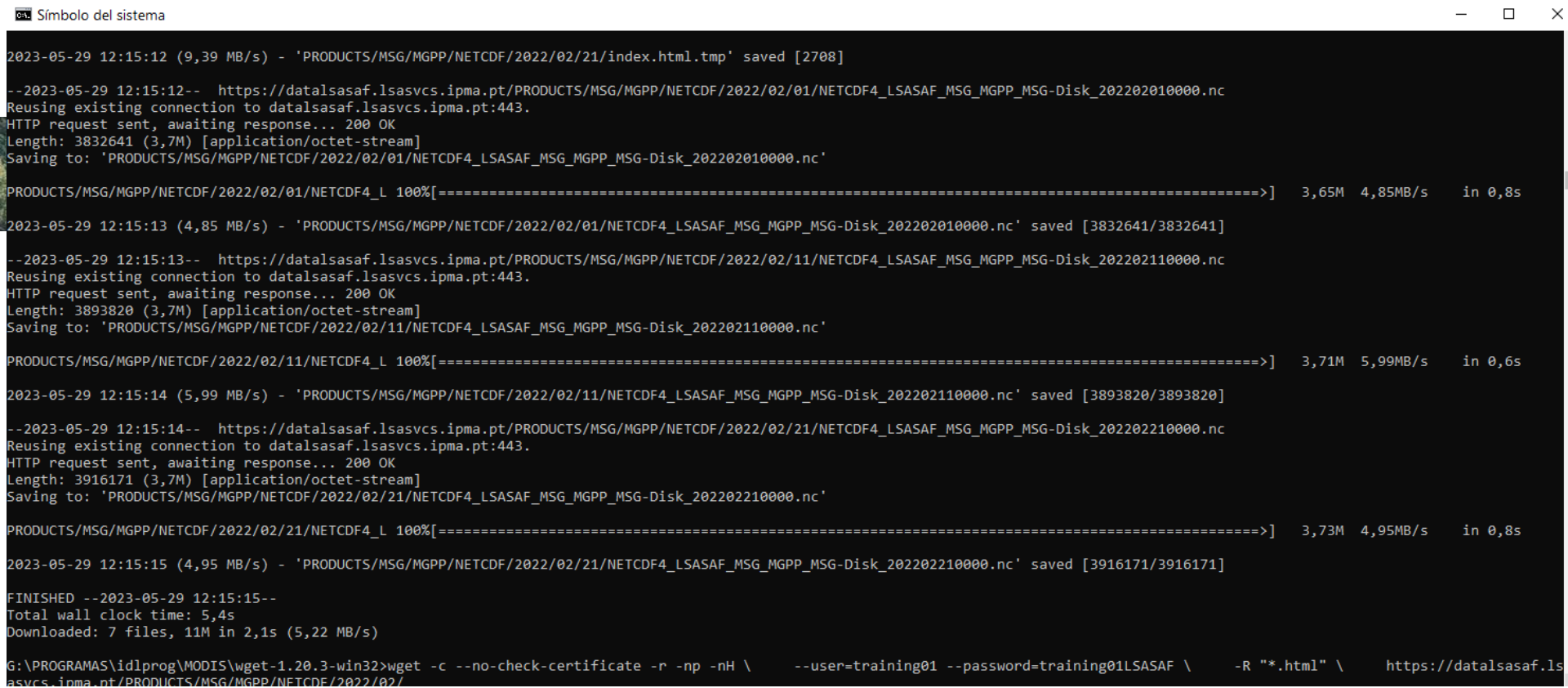

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Roadmap

ECV

APPLICATIONS:
Change detection: VEGA

1

2

3

4

5

6

VEGA LSA SAF

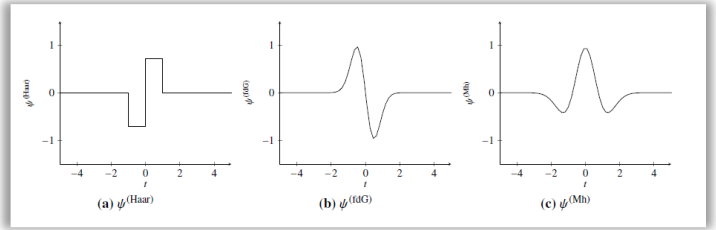
VEG. CHANGE DETECTION

❑ MRA-WT

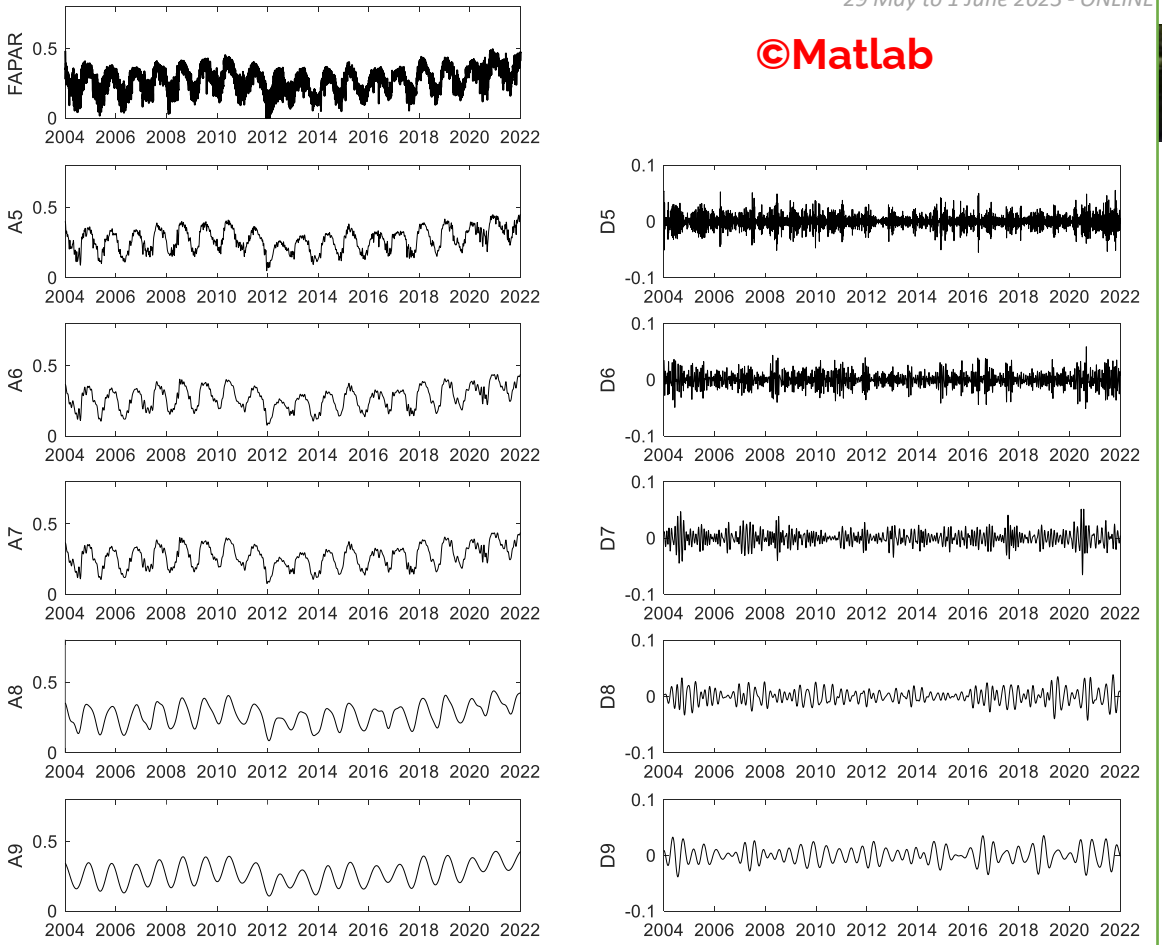
$$f(t) = A_J(t) + \sum_{j=1}^{J} D_j(t)$$

↑

Low-pass filter (LPF)



1. Translating the Wavelet
2. Scaling the Wavelet at different temporal resolutions (dilatation and contraction)



VEG. CHANGE DETECTION

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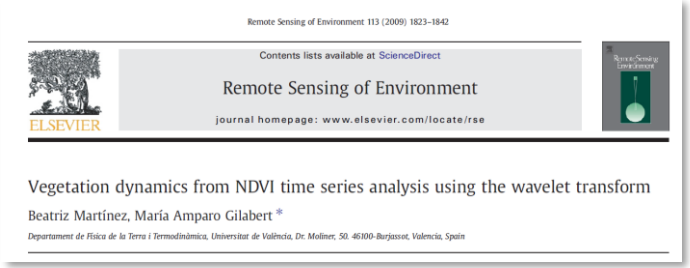

Remote Sensing of Environment 113 (2009) 1823–1842

Contents lists available at ScienceDirect

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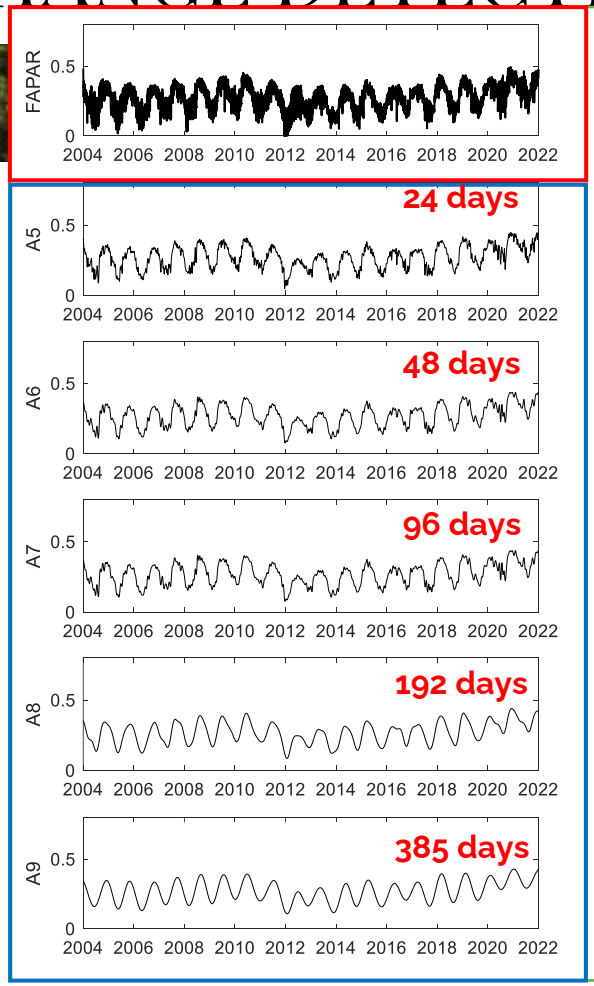
journal homepage: www.elsevier.com/locate/rse

Vegetation dynamics from NDVI time series analysis using the wavelet transform

Beatriz Martínez, María Amparo Gilabert *

Departament de Física de la Terra i Termodinàmica, Universitat de València, Dr. Moliner, 50. 46100-Burjassot, Valencia, Spain



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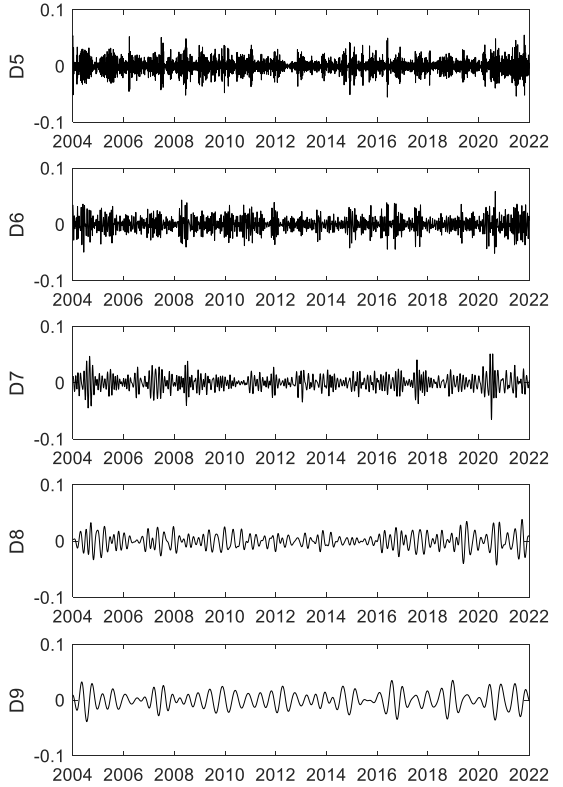


VEG. CHANGE DETECTION

❑ MRA-WT

$$f(t) = A_J(t) + \sum_{j=1}^{J} D_j(t)$$

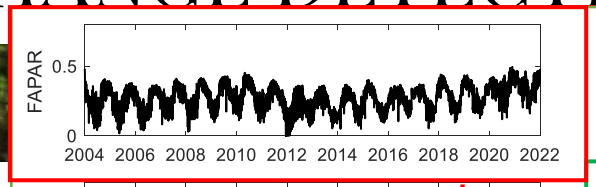
↑

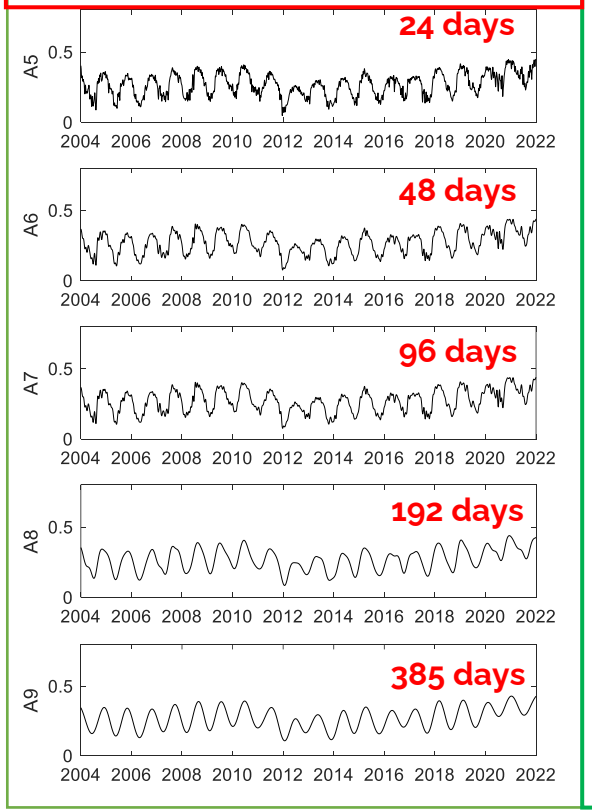
High-pass filter (HPF)

$$f(original) = A_1 + D_1$$

$$f(original) = (A_2 + D_2) + D_1$$

$$D_2 = (A_1 - A_2)$$





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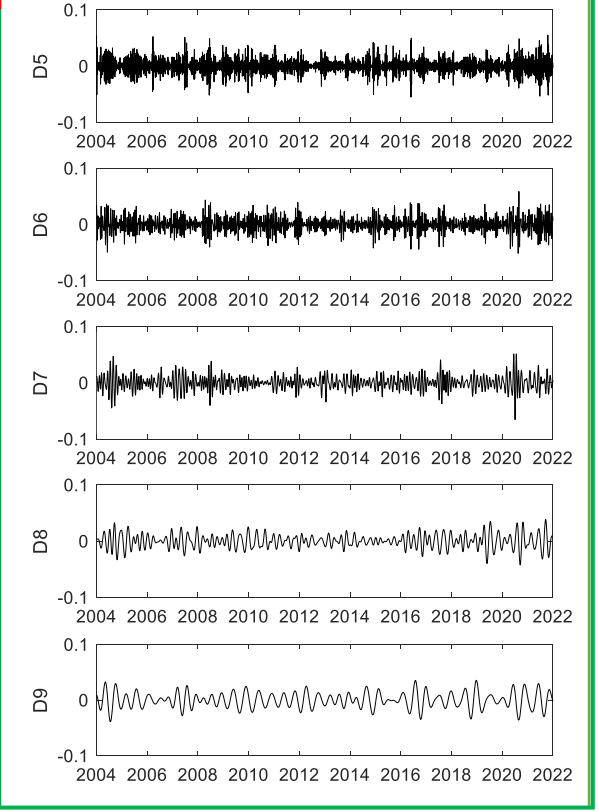


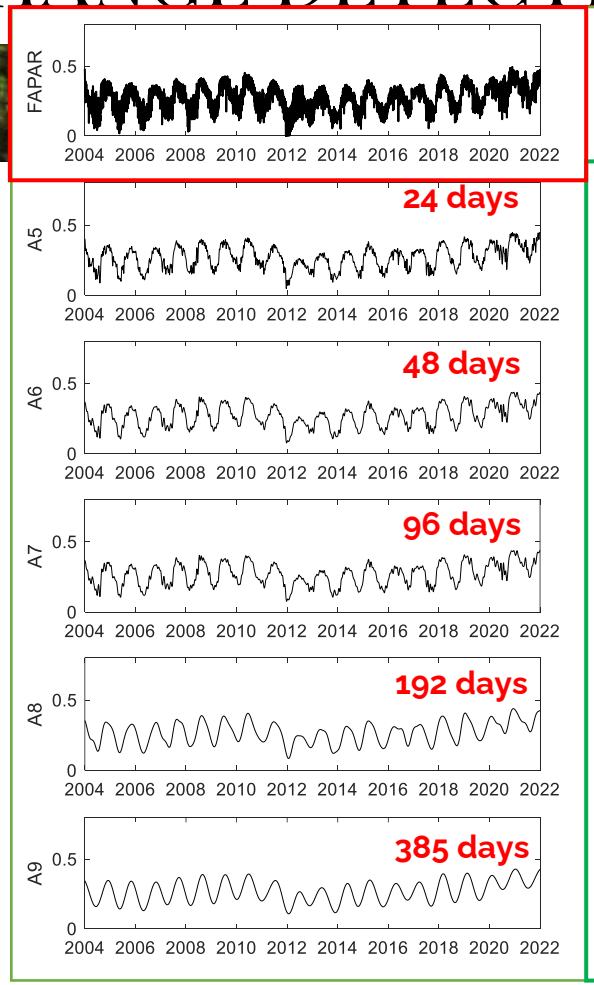
VEG. CHANGE DETECTION

❑ MRA-WT

$$f(t) = A_J(t) + \sum_{j=1}^{J} D_j(t)$$

Level 9

$$f(t) = A_9 + \Sigma D_{1-9}$$



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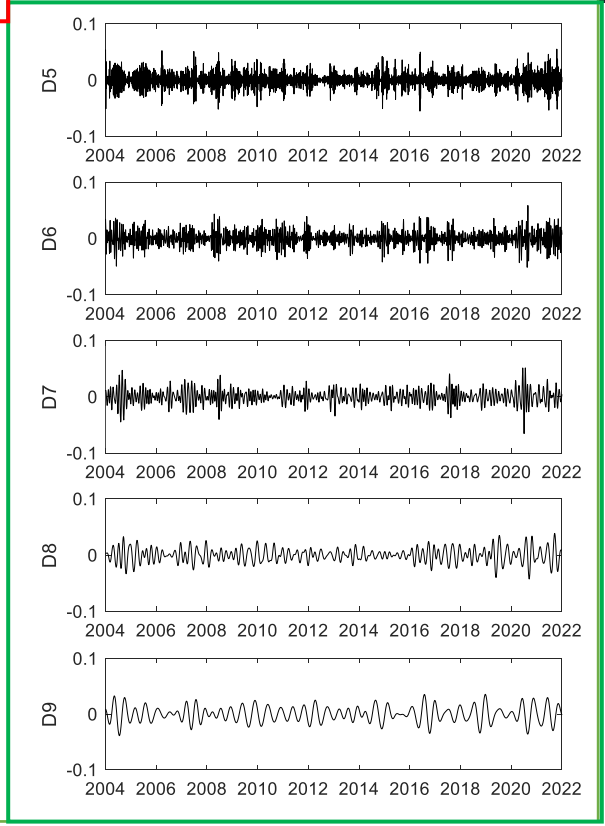


VEG. CHANGE DETECTION

❑ MRA-WT

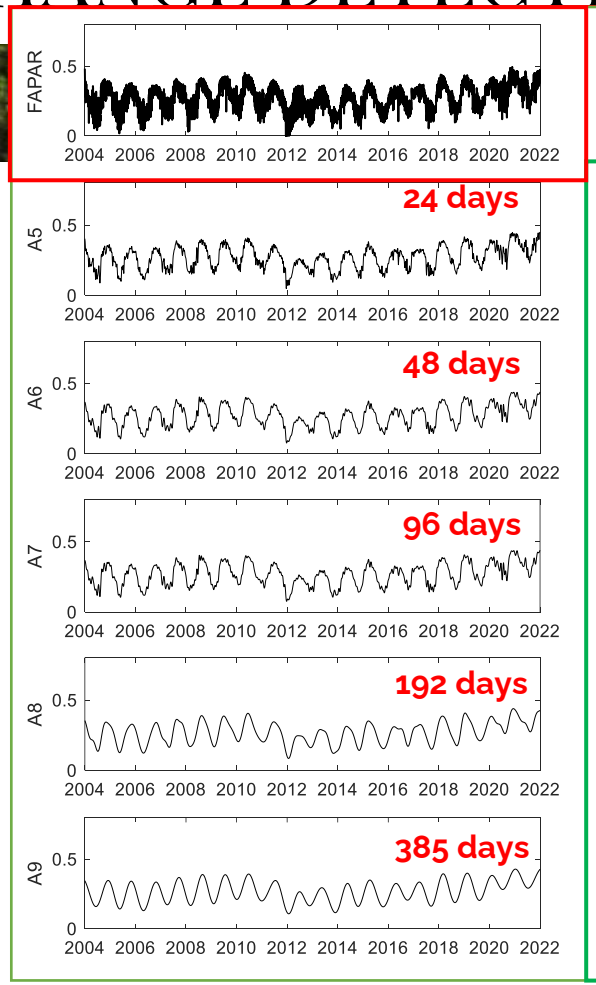
$$f(t) = A_J(t) + \sum_{j=1}^{J} D_j(t)$$

Level 9

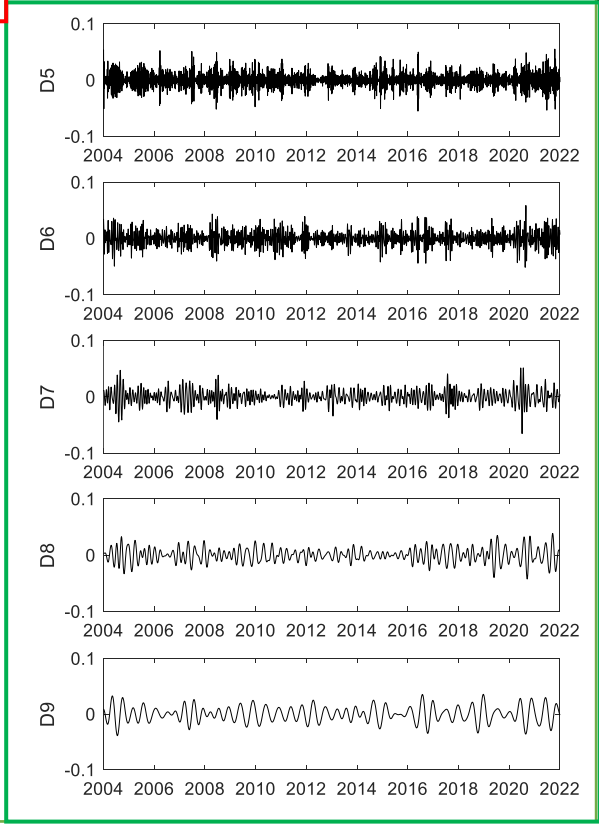
$$f(t) = A_9 + \Sigma D_{1-9}$$

Inter-anual component

Magnitud and direction of the slope using Mann-Kendal and Theil-Sen



©Matlab



VEG. CHANGE DETECTION

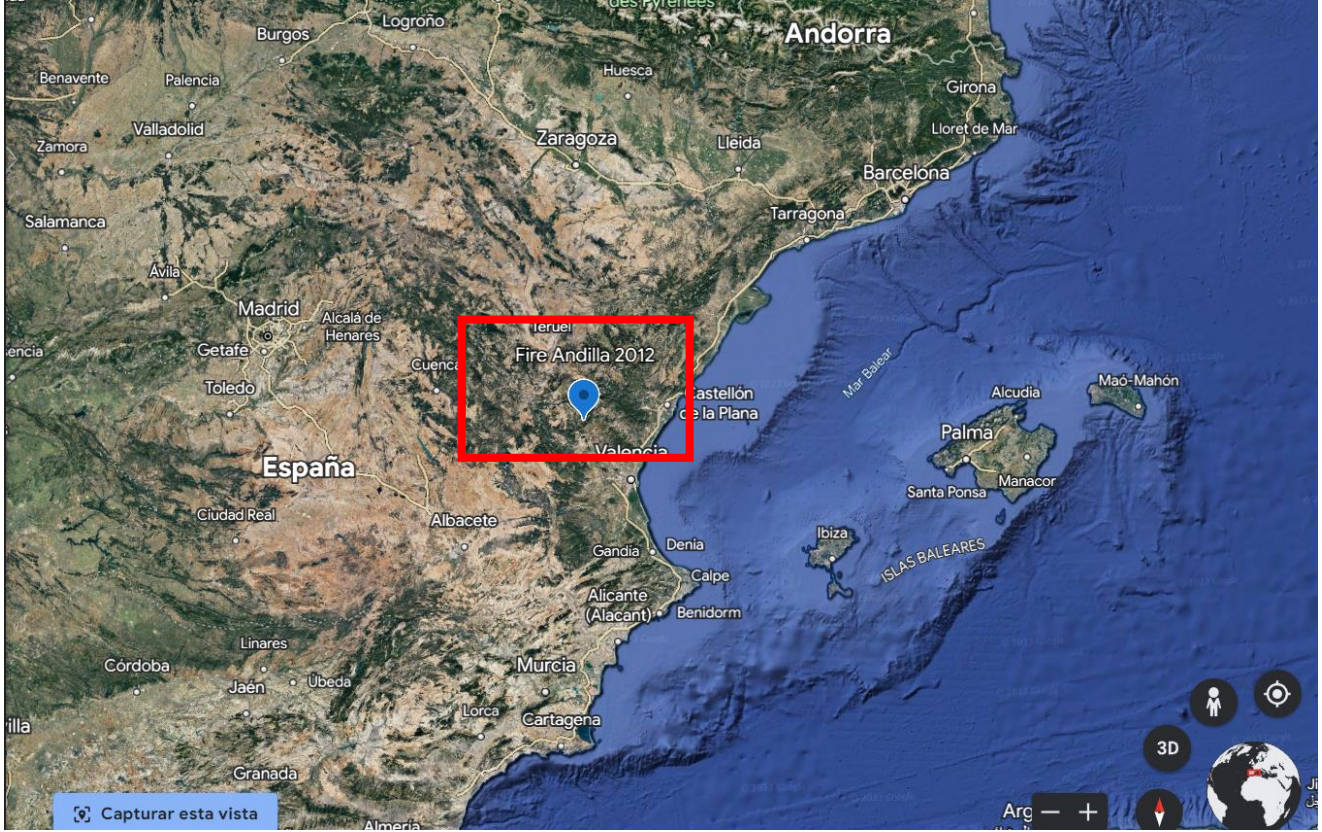
❑ Multiresolution analysis based on wavelet transform (MRA-WT)

VERY IMPORTANT, the MRA does not accomplish change detection on the signal.

The MRA is only a filter method that allows you to have different details components (*D*) or approximated components (*A*).

To perform the change detection → We chose the **Man kendall and Sen slope** method to evaluate the inter-annual changes.

The levels (j) in which you decompose the signal, will depend on the **mother wavelet** and **on the temporal resolution** of your data (*see eq.10 in 09-RSE paper*).



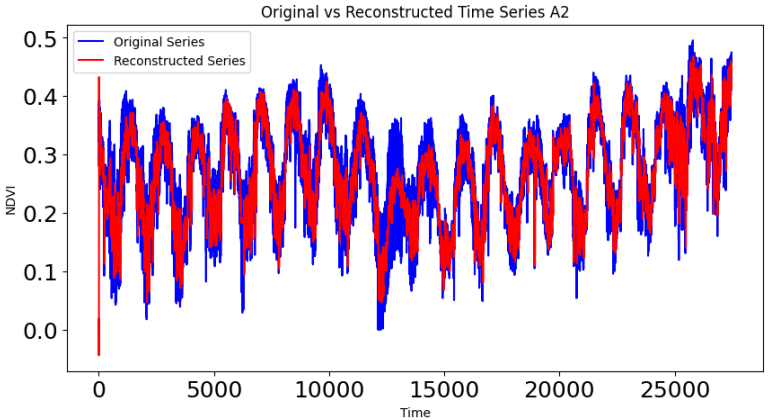
https://gitlab.com/helpdesk.landsaf/lsasaf_data_access/-/blob/main/examples/thredds/thredds_msg_mdfapar_point.ipynb

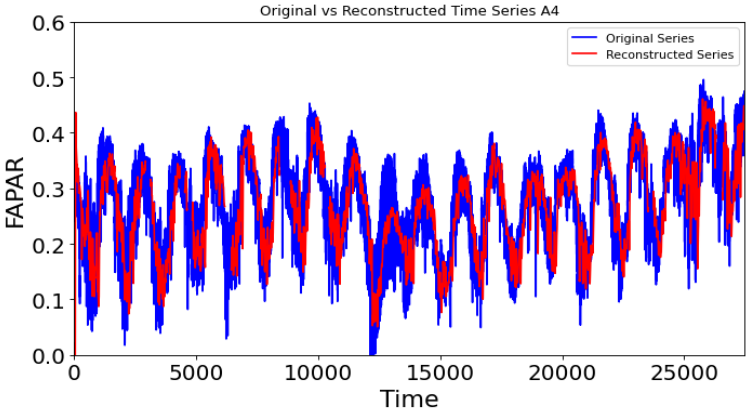
```
# Change here your user credentials
server_user="training01"
server_passwd="training01LSASAF"

LatLonPoint = [39.03,-0.8]
```

VEG. CHANGE DETECTION

❑ **Python (google colab)**

```
import pywt
wavelet = 'sym4'
level = 4
# Perform wavelet decomposition to obtain the approximation and detail coefficients at each
level
coeffs = pywt.wavedec(data, wavelet, level=level)

# Extract the approximation coefficients at level 4
approx_coeffs_level_4 = coeffs[0]
# Perform wavelet reconstruction using only the approximation coefficients
reconstructed_series = pywt.upcoef('a', approx_coeffs_level_4, wavelet,
level=level)[:len(data)]
```

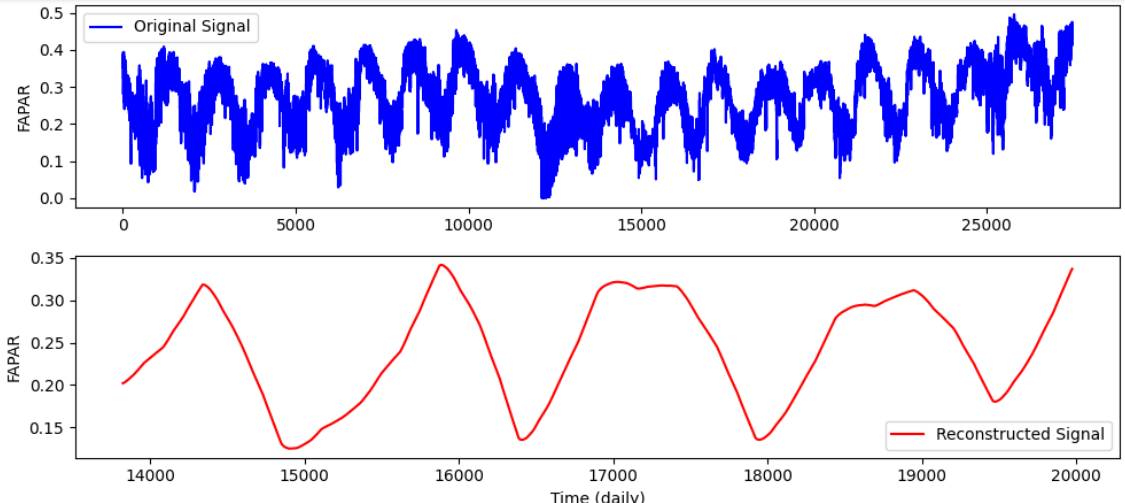




VEG. CHANGE DETECTION

- **Python (google colab)**

```
wavelet = 'sym4'
level = 9

# Perform wavelet decomposition to obtain the approximation and detail coefficients at each level
coeffs = pywt.wavedec(data, wavelet, level=level)
# Extract the approximation coefficients at level 9
approximation_coeffs = coeffs[0]
#WAVEREC
# Perform wavelet reconstruction using only the approximation coefficients
reconstructed_signal = pywt.waverec([approximation_coeffs] + [None] * level, wavelet)
```

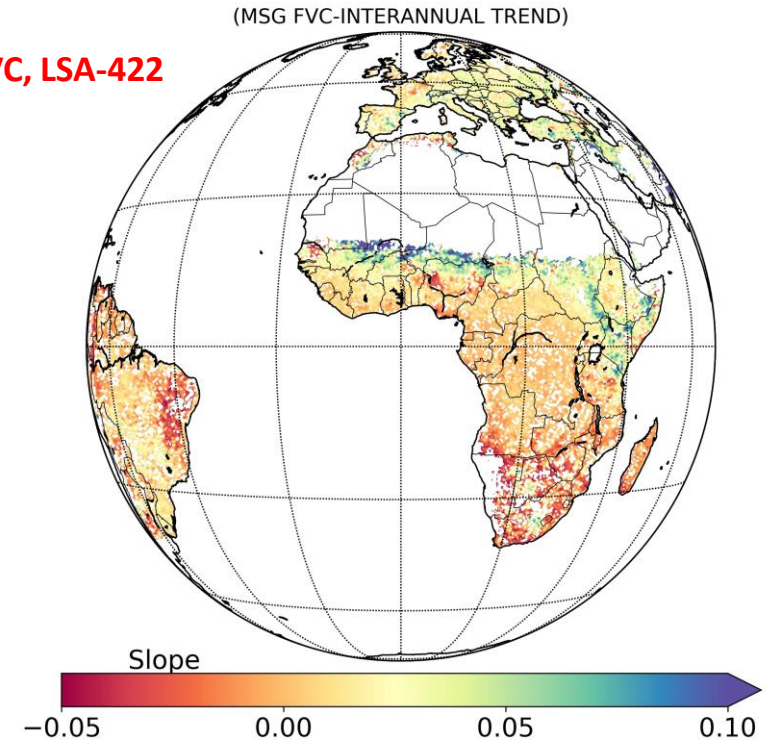


https://pywavelets.readthedocs.io/en/latest/ref/2d-decompositions-overview.html

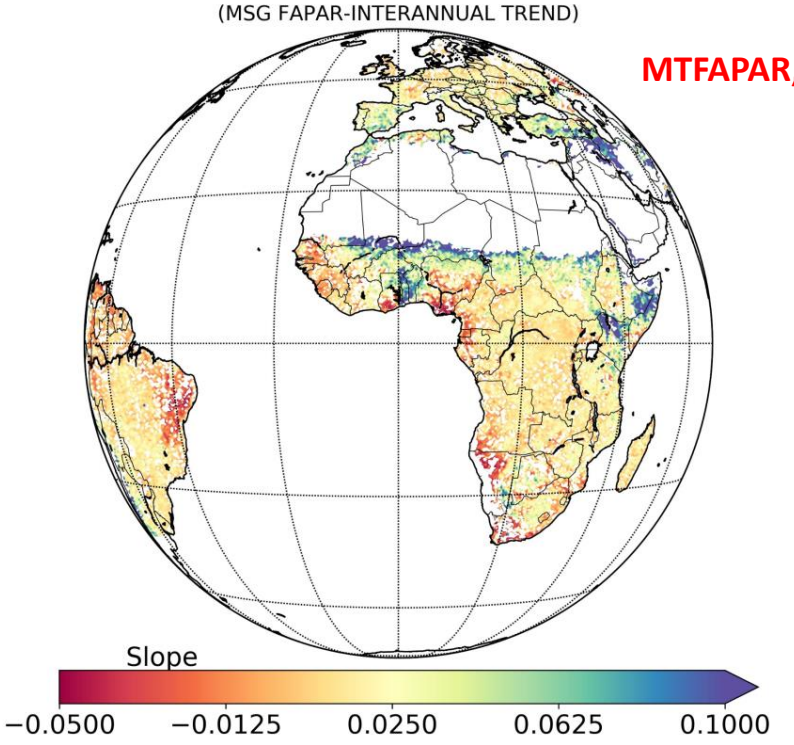
VEG. CHANGE DETECTION

❑ MRA-WT to FAPAR and FVC CDR (2005-2020)

MTFVC, LSA-422



MTFAPAR, LSA-426

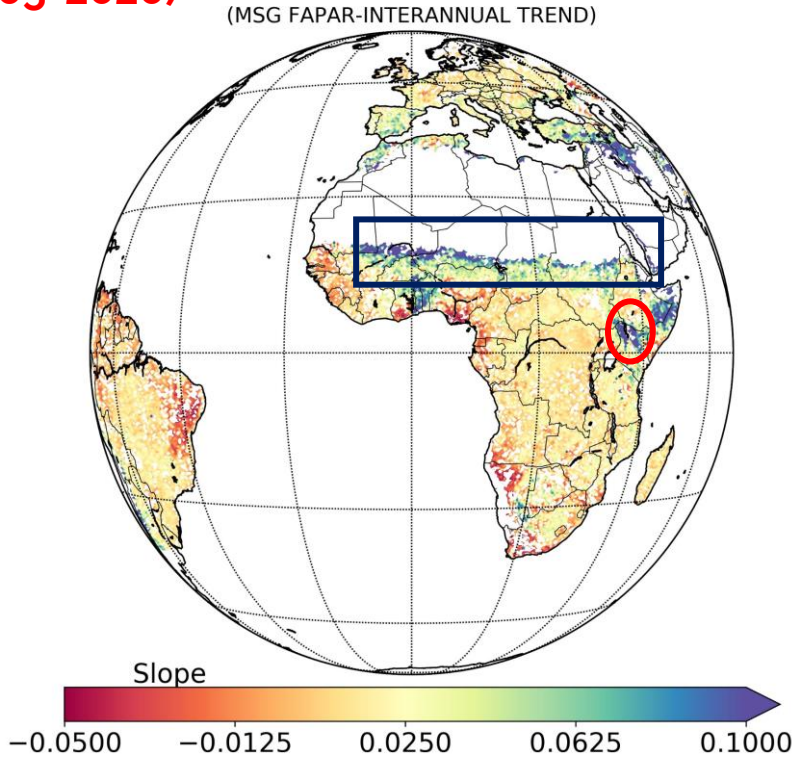


VEG. CHANGE DETECTION

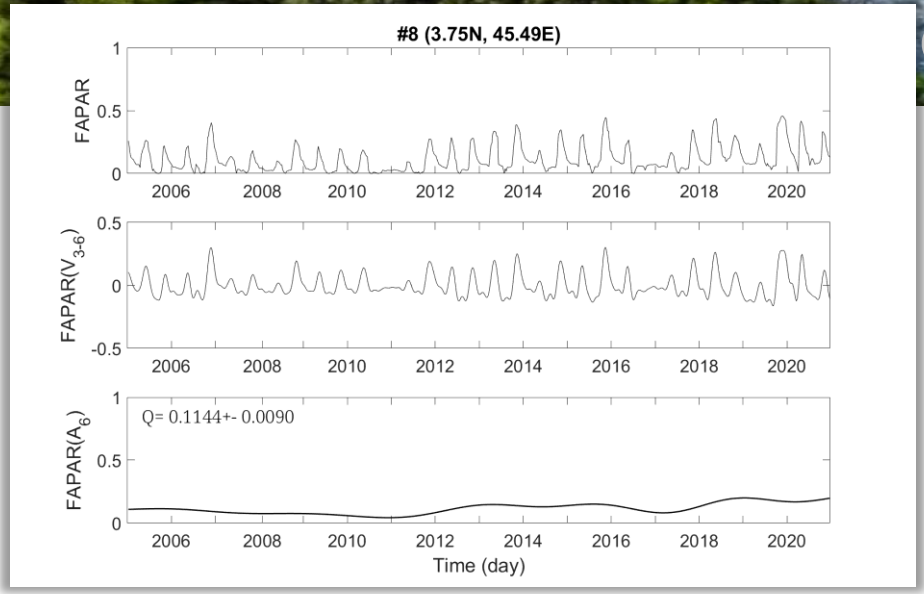
❑ MRA-WT to FAPAR and FVC CDR (2005-2020)

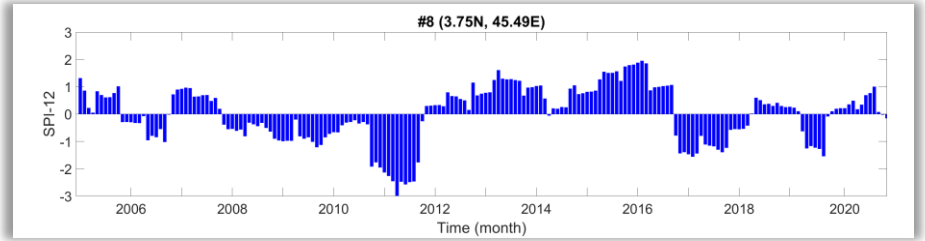
Extreme values→ Red and blue

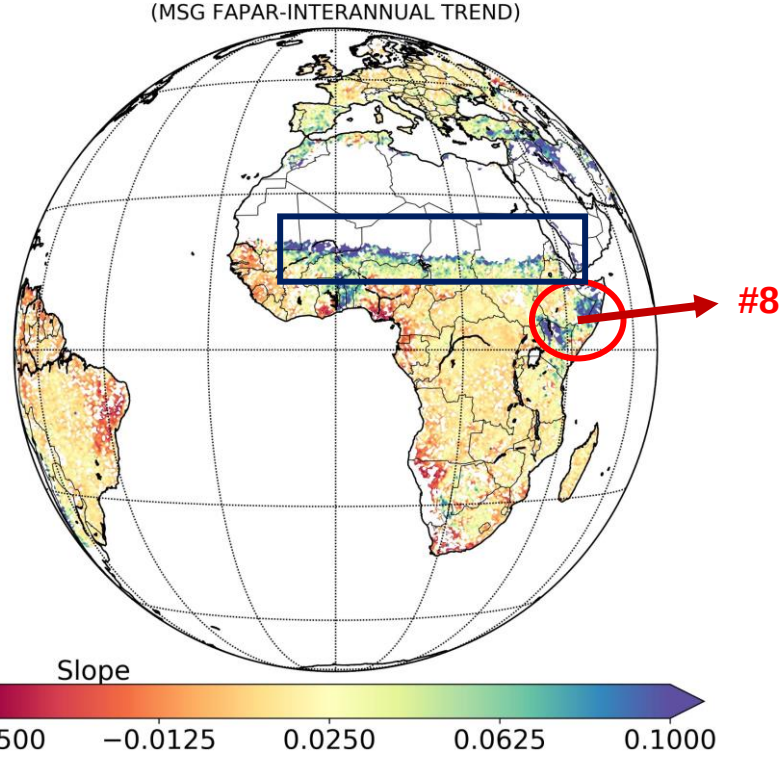
A *greening* is observed concentrated on 10° N and 16° N, particularly in the central and eastern Sahel region and east part of Africa (Horn of Africa), which, particularly, was affected by severe drought periods in 2011 and 2016-2017.



VEG. CHANGE DETECTION



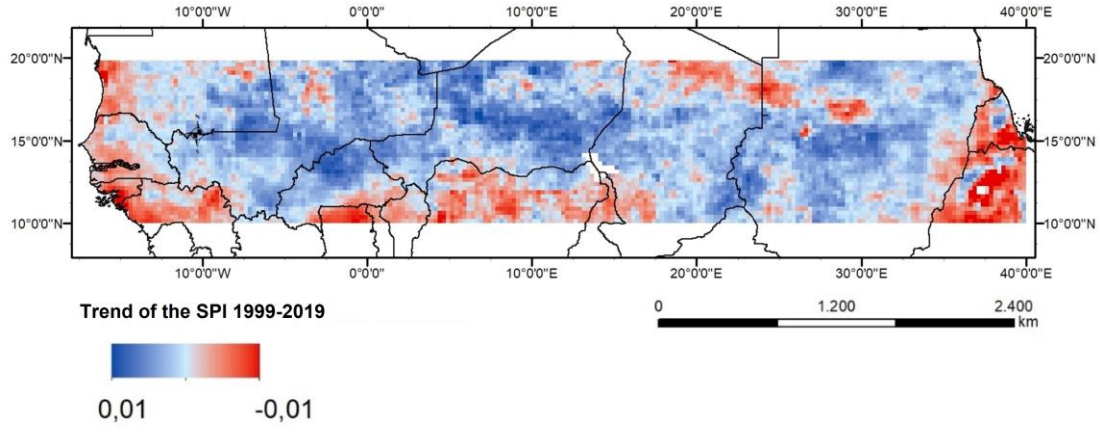


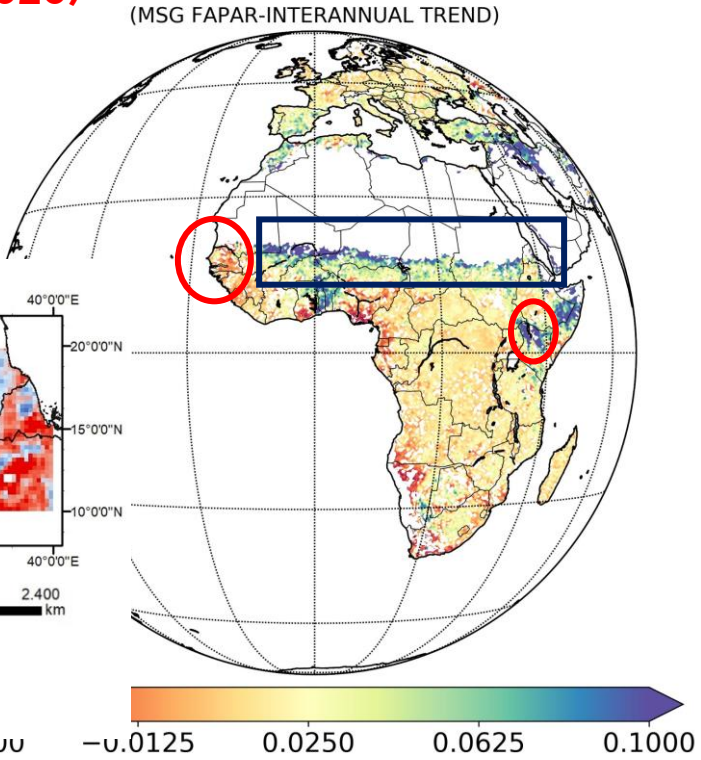


VEG. CHANGE DETECTION

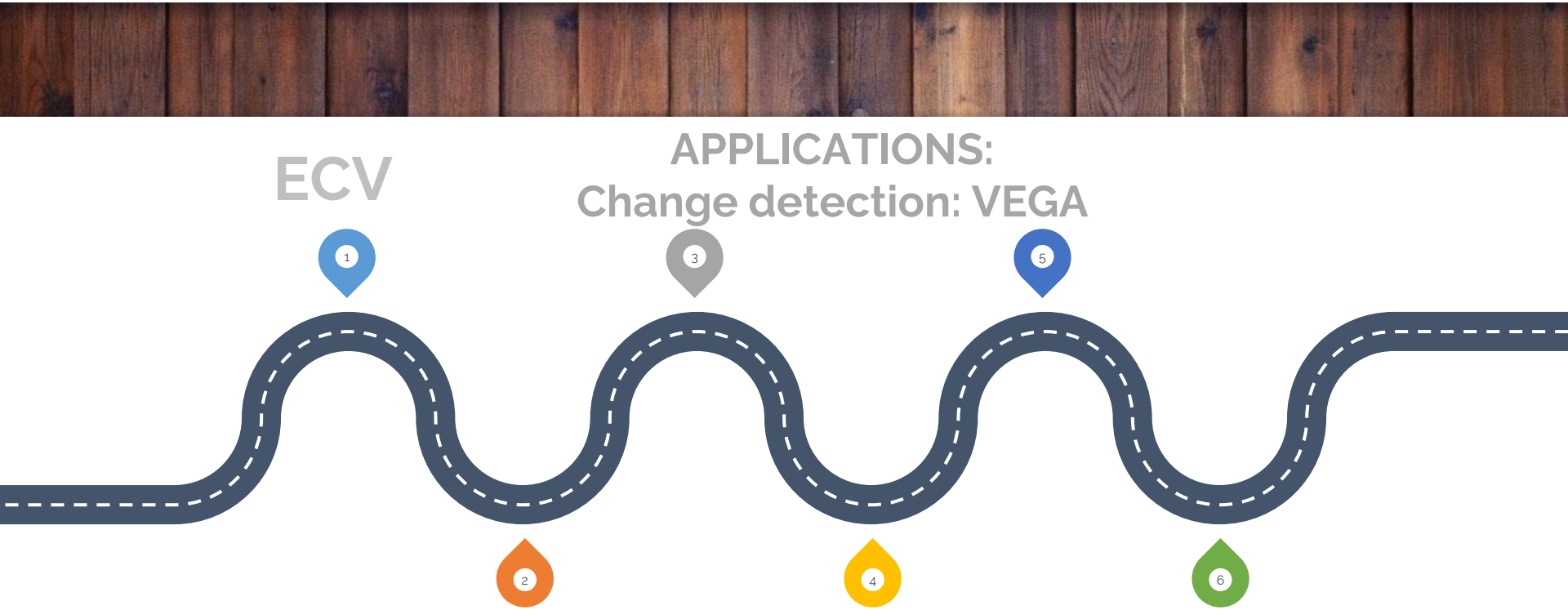
❑ MRA-WT to FAPAR and FVC CDR (2005-2020)

SPI index computed from GPM data (GPM3IMERG, monthly and 0.1° × 0.1° temporal and spatial resolutions).





Roadmap

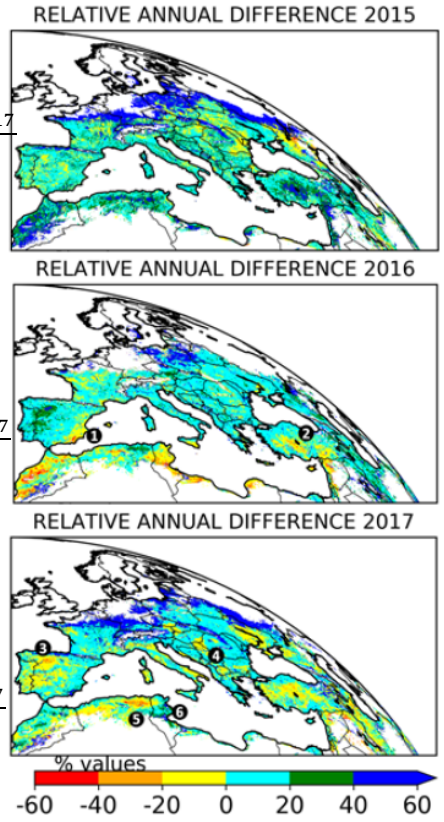

ECV
APPLICATIONS:
Change detection: VEGA
1
3
5
2
4
6
VEGA LSA SAF
APPLICATIONS:
Change detection: MGPP

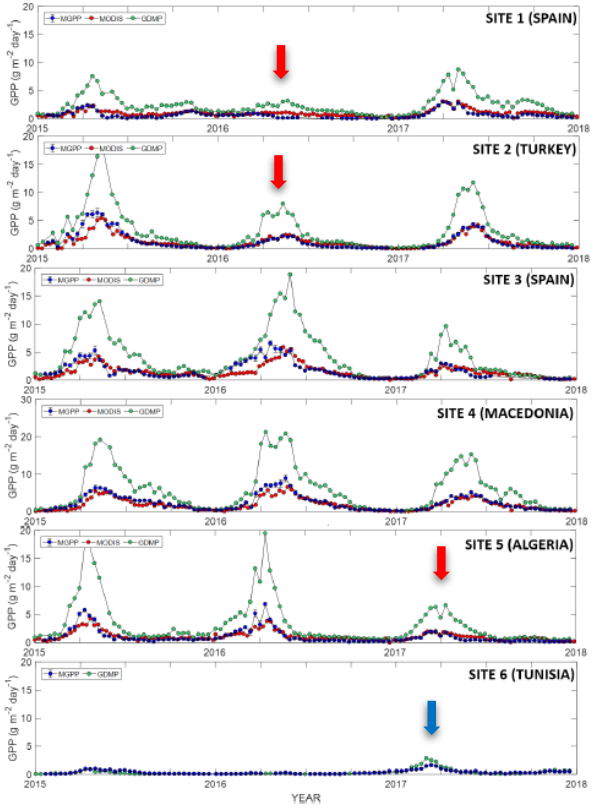
VEG. CHANGE DETECTION

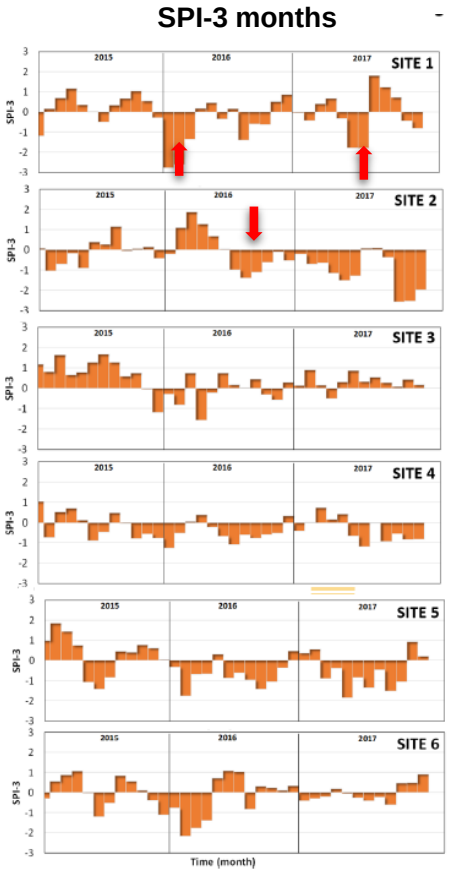
$$\frac{\overline{FAPAR}_{2015} - \overline{FAPAR}_{2015-2017}}{\overline{FAPAR}_{2015-2017}}$$

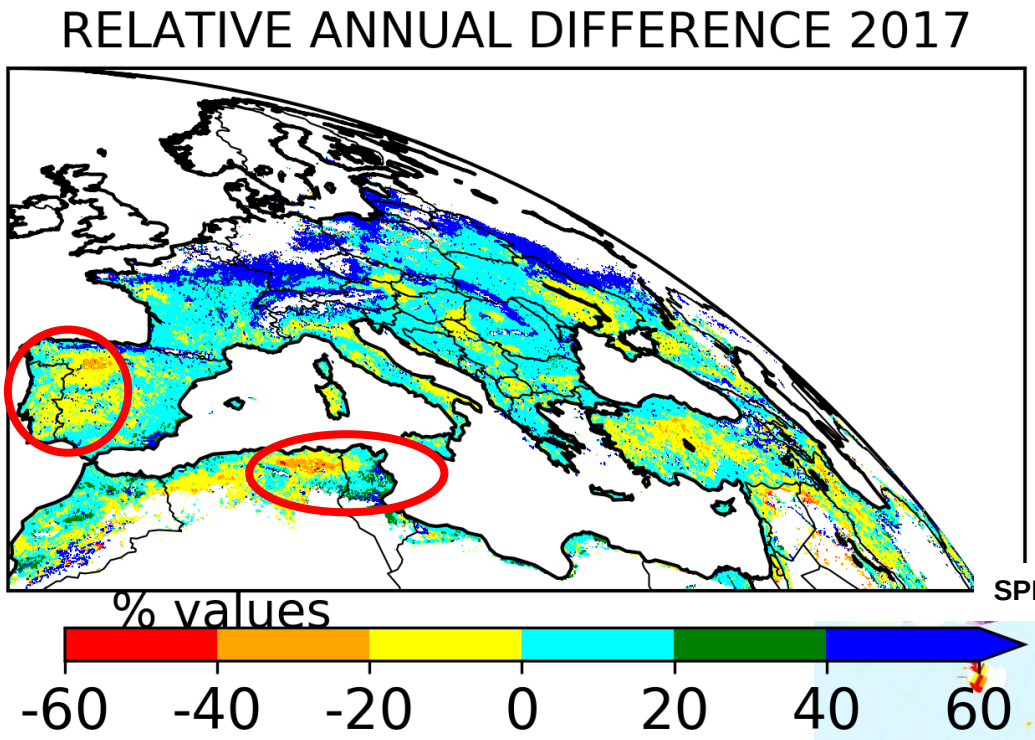
$$\frac{\overline{FAPAR}_{2016} - \overline{FAPAR}_{2015-2017}}{\overline{FAPAR}_{2015-2017}}$$

$$\frac{\overline{FAPAR}_{2017} - \overline{FAPAR}_{2015-2017}}{\overline{FAPAR}_{2015-2017}}$$

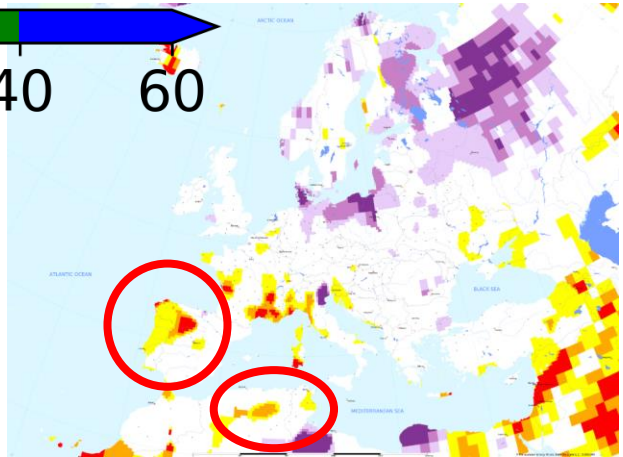






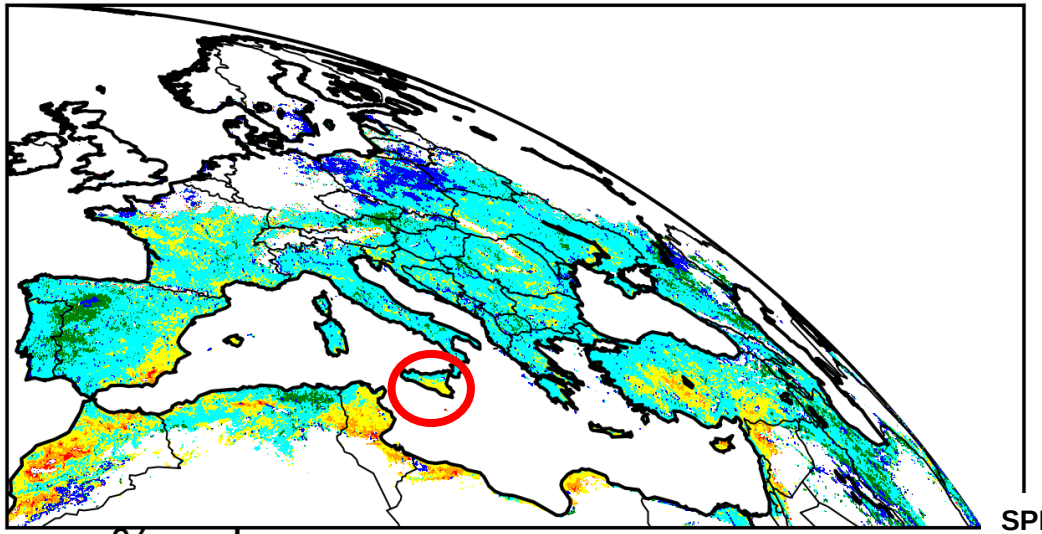


SPI-12 (DEC2016-DEC2017)

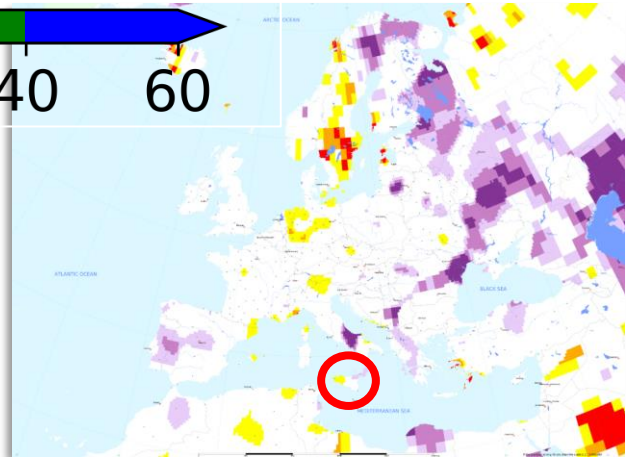


Standardized Precipitation Index (SPI) values provided by the European Drought Observatory system. (https://edo.jrc.ec.europa.eu)

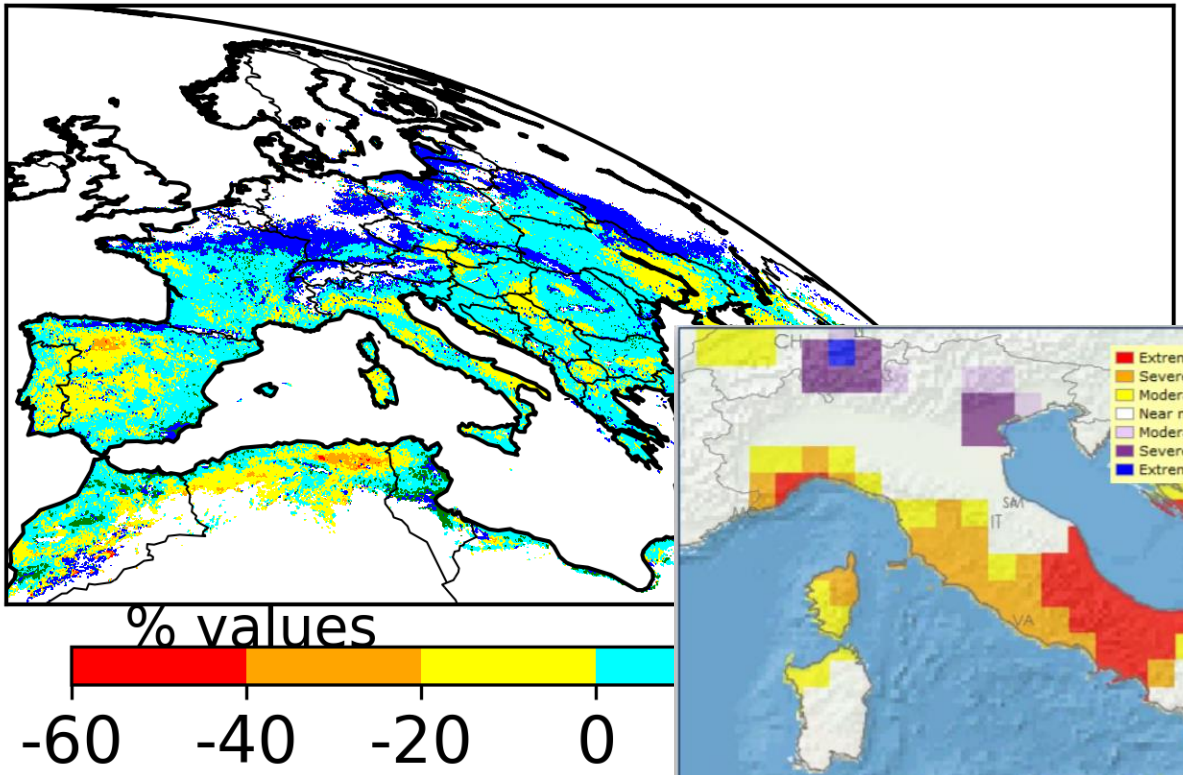
RELATIVE ANNUAL DIFFERENCE 2016



SPI-12 (DEC2015-DEC2016)

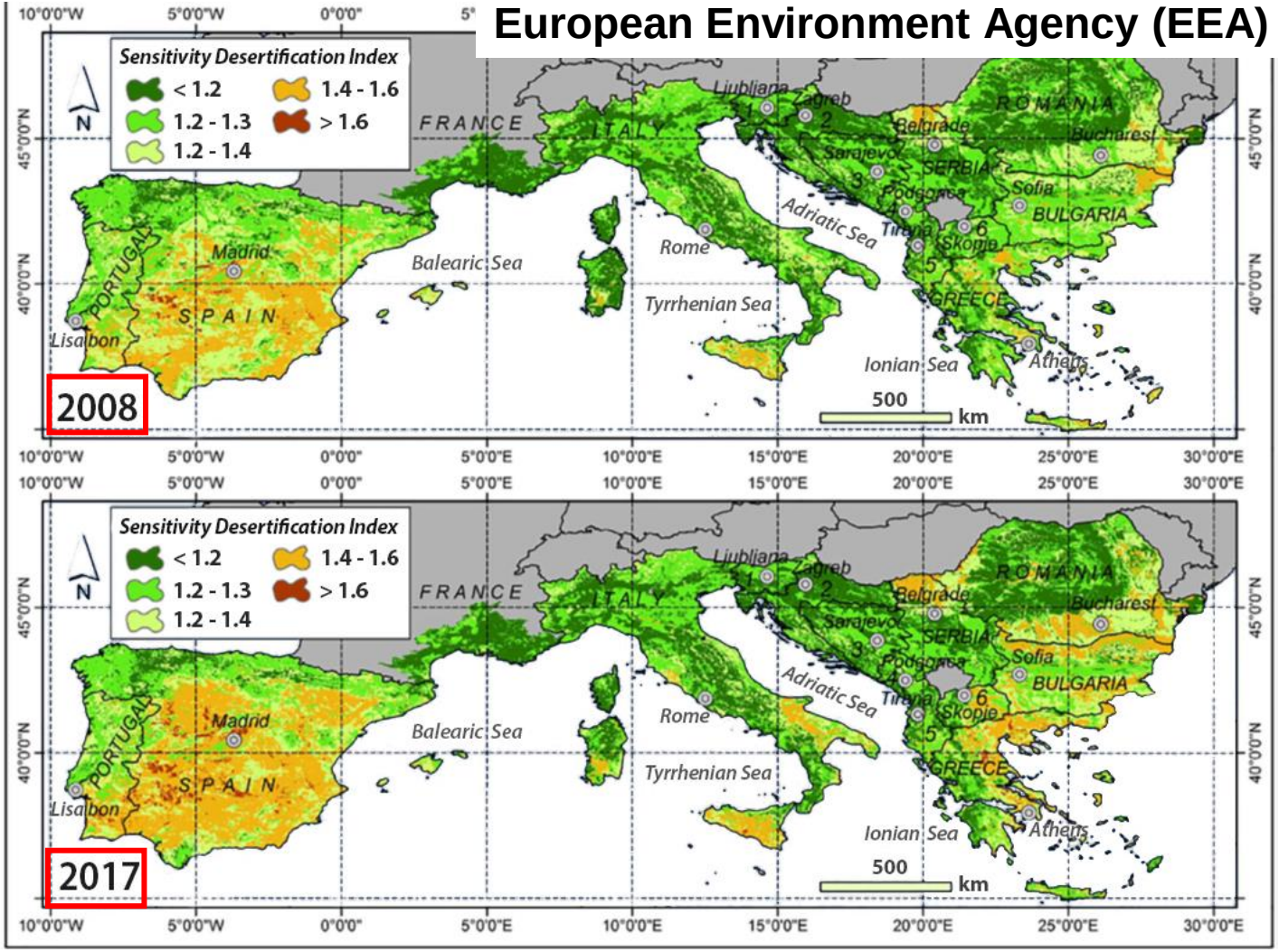


RELATIVE ANNUAL DIFFERENCE 2017

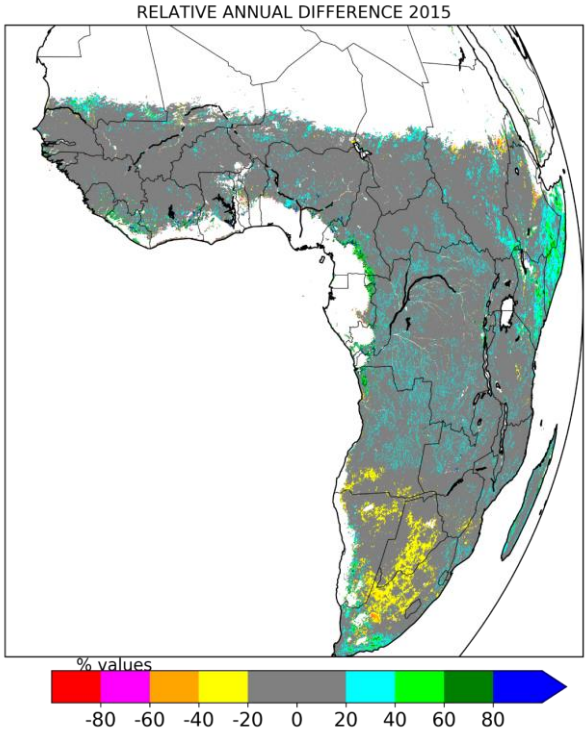


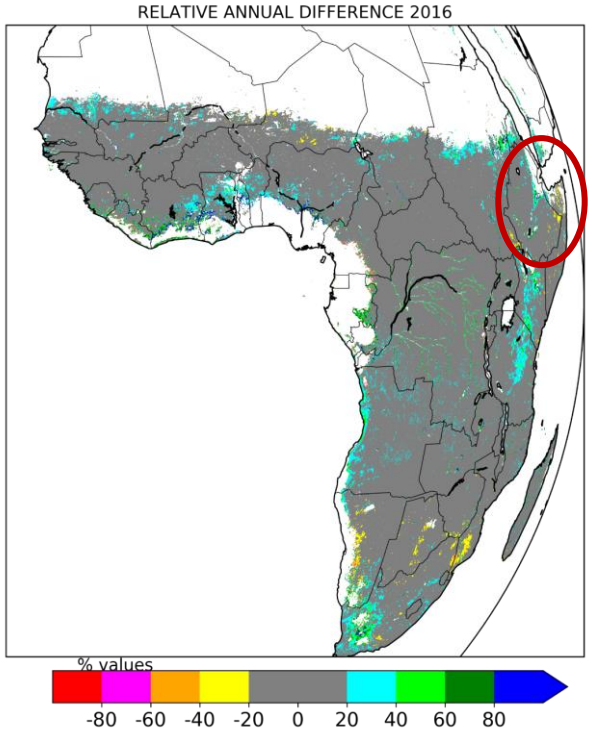
Map of SPI-3 for the period April, May, and June 2017 across Italy. *EDO Analytical Report*

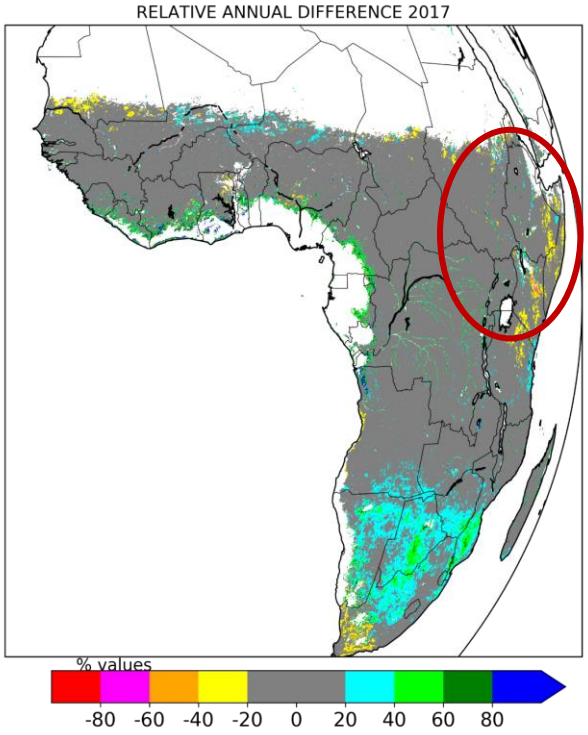
European Environment Agency (EEA)



VEG. CHANGE DETECTION







Messages to take home....

- **CLIMATE DATA RECORD of MSG VEGA (LAI, FVC, FAPAR) products** have shown to be a good alternative for vegetation change detection at MSG scale.
- **Ecosystem change detection understanding** can strongly benefit when other CDR are available, such as DMET [LSA-312].
- **The future MGPP** CDR will contribute to the knowledge of how these weather extremes events are affecting our ecosystem and also how it is adapting.
- **Important issues** in vegetation change detection analysis: Considered method, variables used and analyzed time period.

Thanks!

Any questions?

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- https://www.uv.es/uvers