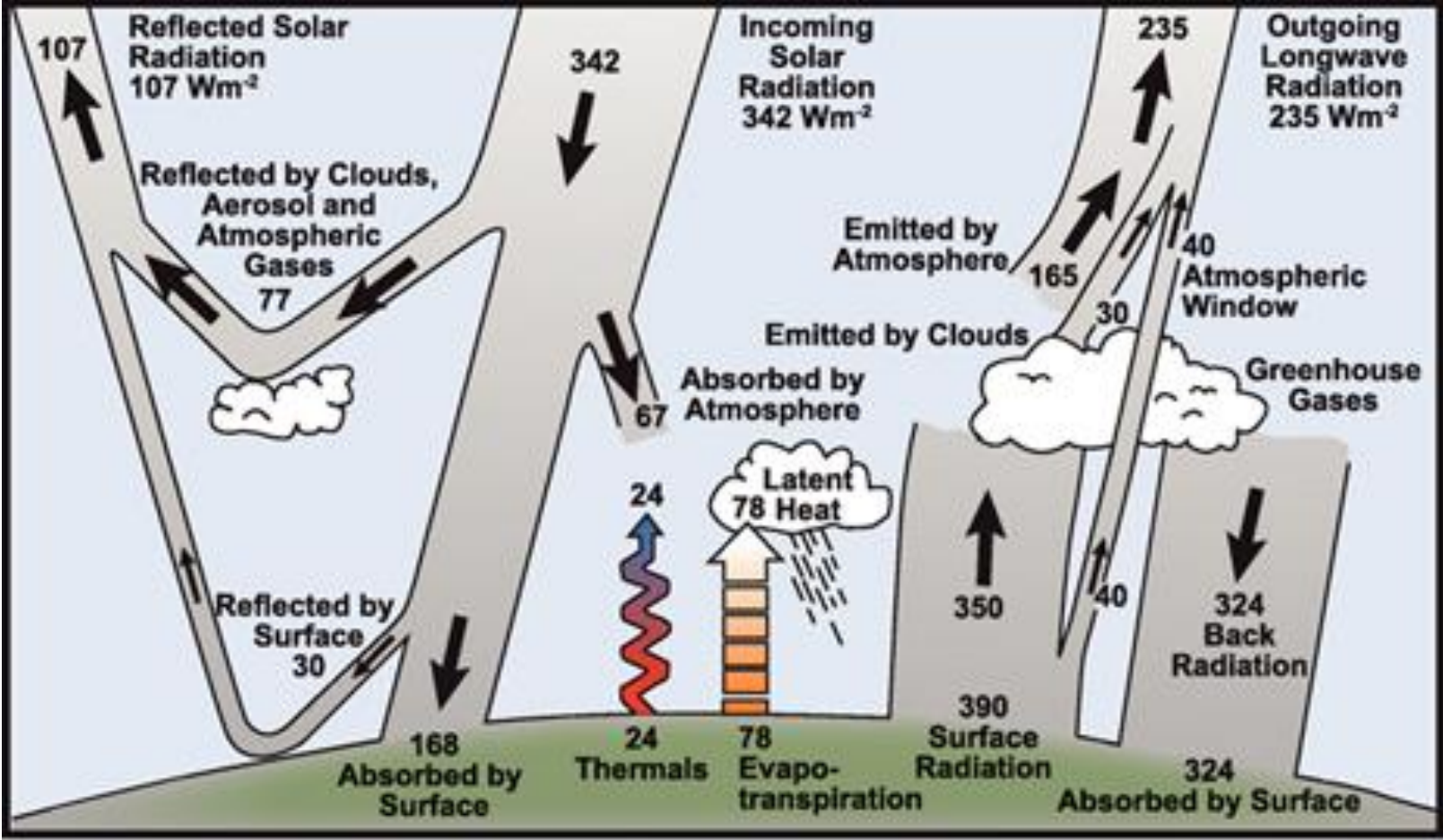


# LSA SAF Products in D&V Data Cube

11 May 2021, Carla Barroso, João P. Martins



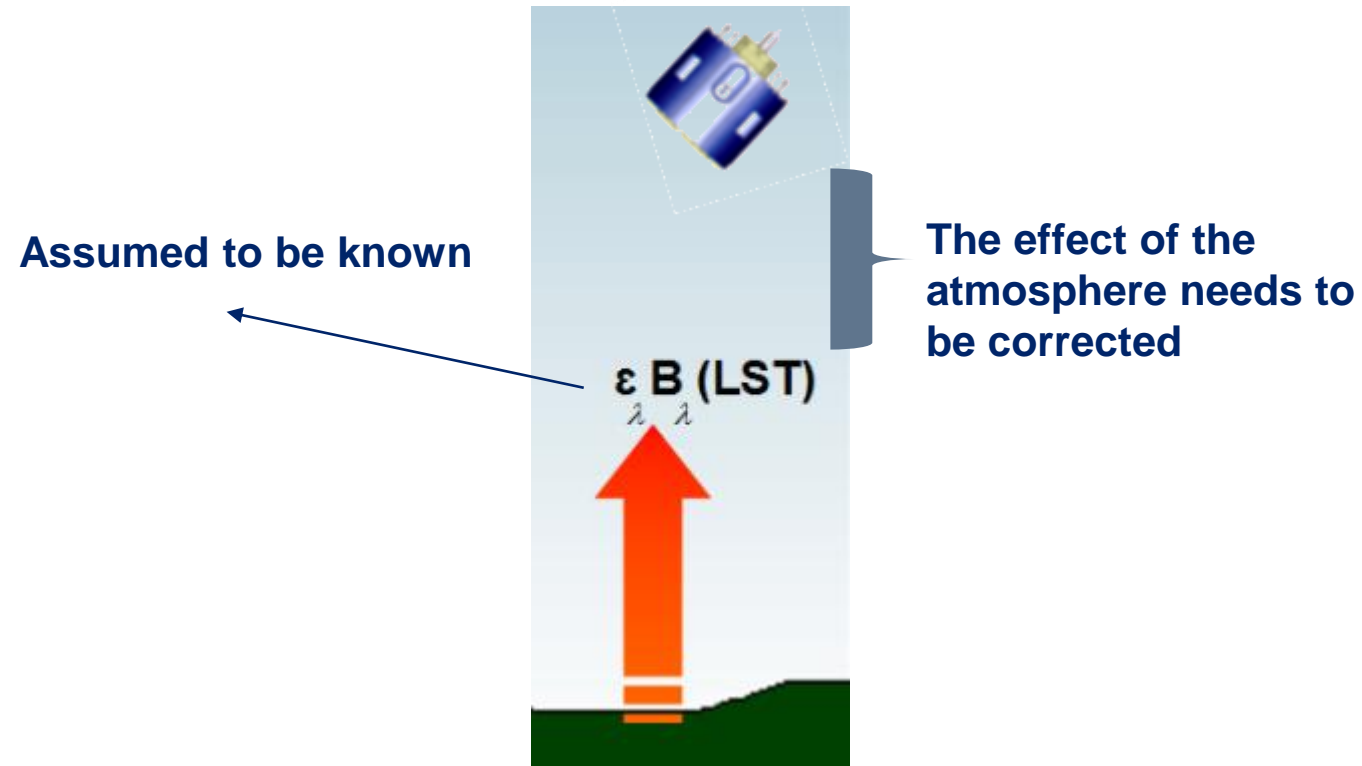
# LSA SAF Products



# Land Surface Temperature (LST)

Land Surface Temperature (LST), the radiative skin temperature of the land surface

Corresponds to thermal emission from the top thin layer of a few micrometers on the surface (up to 50  $\mu\text{m}$ ).



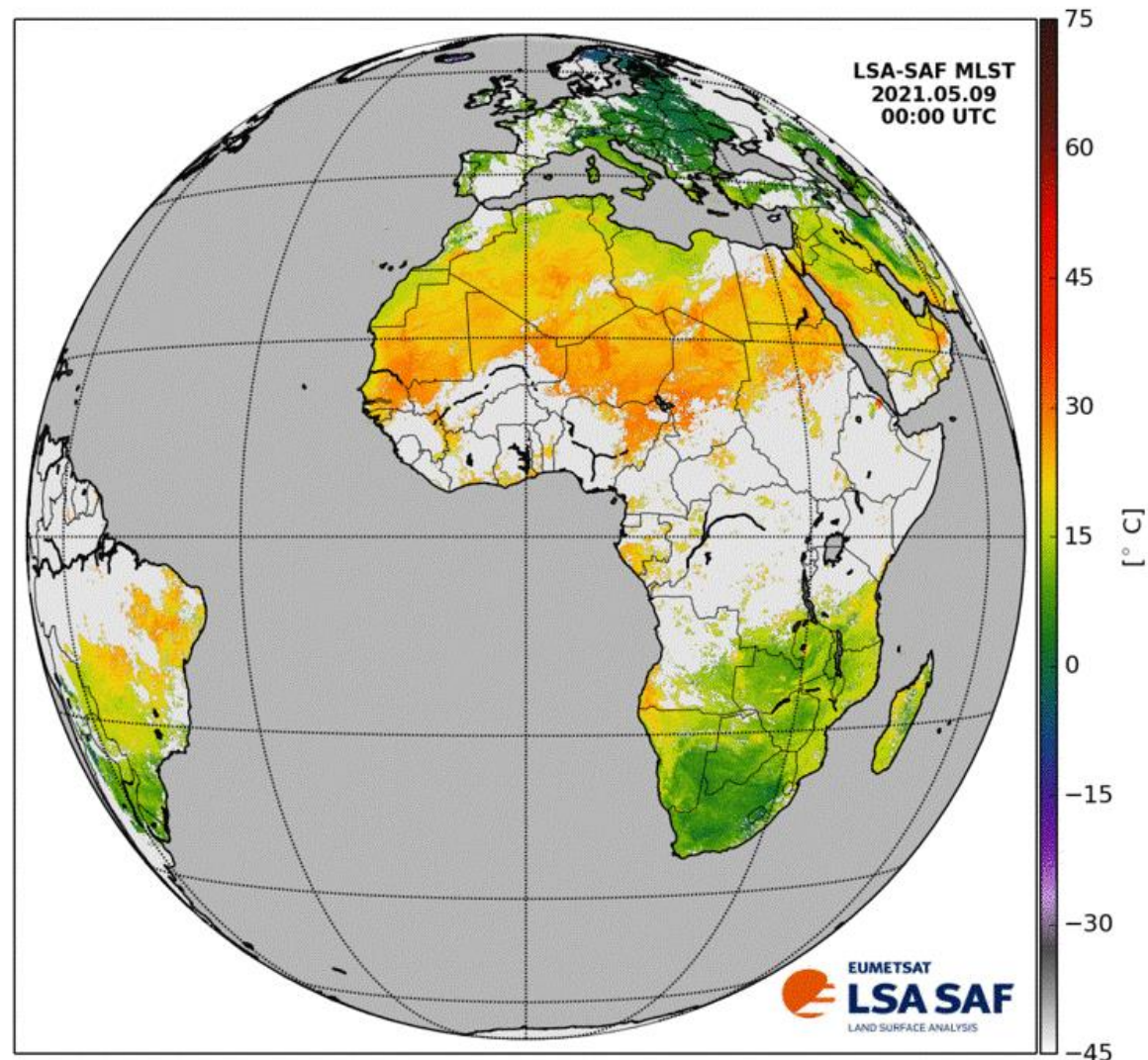
## LSA SAF LST retrieval

- Generalised Split-Window' (GSW) formulation first developed for MODIS and AVHRR by Wan and Dozier (1996):

$$- \text{LST} = f ( \text{Tb}_{10.8}, \text{Tb}_{12.0}, \epsilon_{10.8}, \epsilon_{12.0}, \dots )$$



# Land Surface Temperature (LST)



## LSA SAF LST frequency & temporal coverage

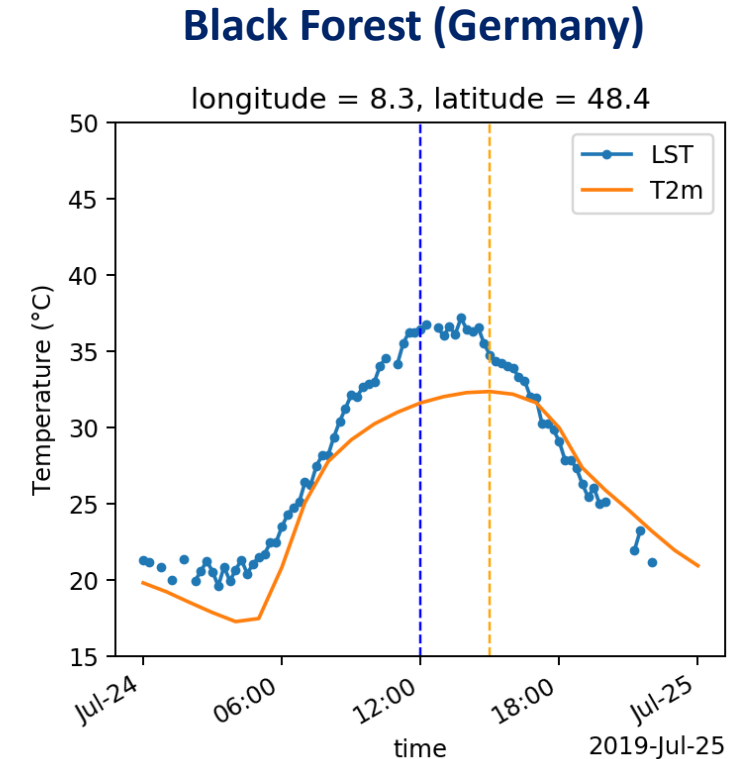
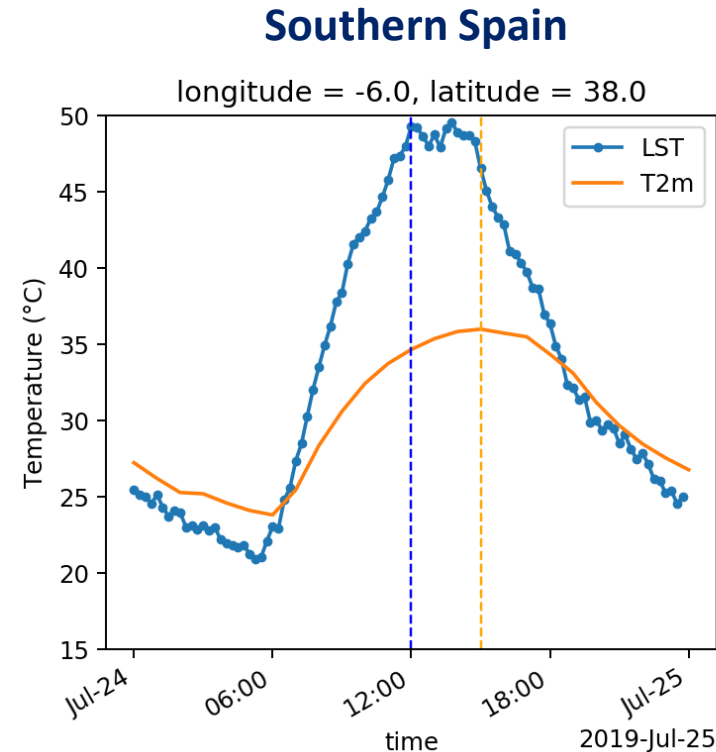
- LSA SAF LST is generated on an operational basis with 15 min. frequency > 2004

- Retrieved for **clear-sky** conditions

\* **A new** all-sky LST product is available from March 2021, providing skin temperature estimate for all land pixels within the SEVIRI disk, every 30 min, for both clear and cloudy conditions (Martins et al, 2019).

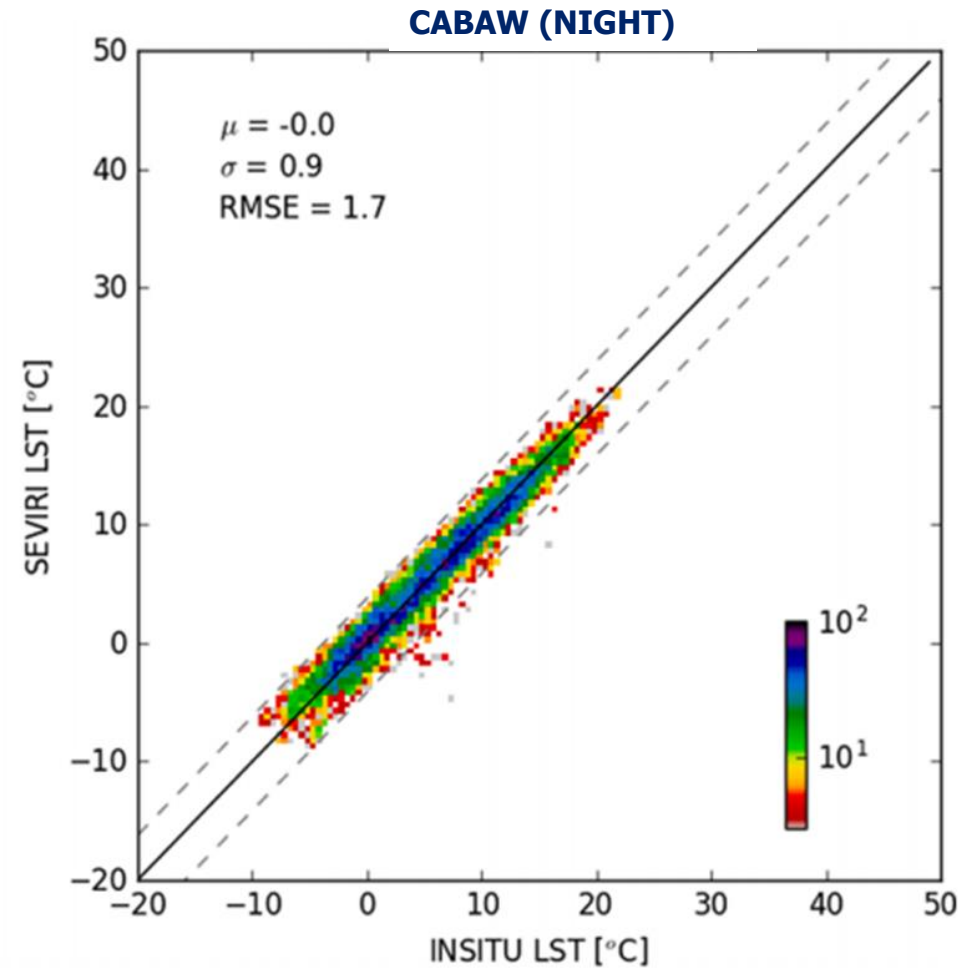
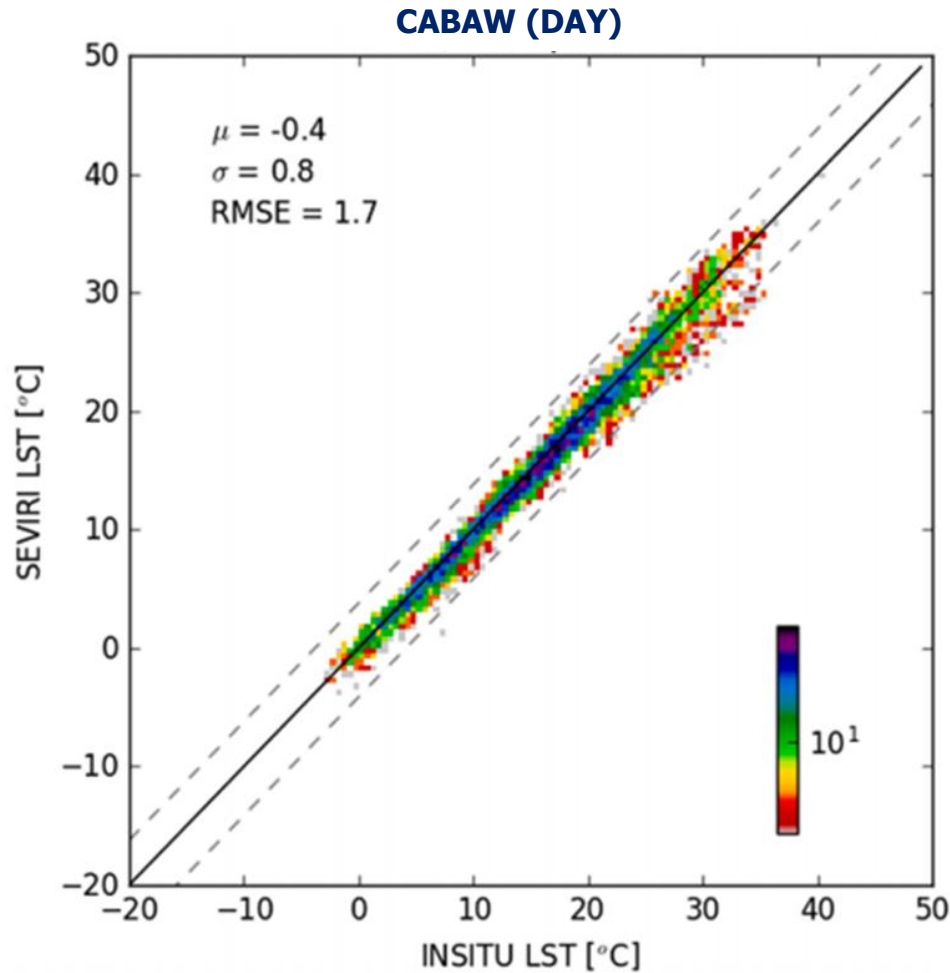
# Land Surface Temperature (LST)

- Although strongly correlated,  $LST \neq T2m$ 
  - **LST** responds rapidly to insolation – **maximum around noon**;
  - **T2m** keeps increasing past noon, as surface fluxes transfer energy from the surface to the low-atmosphere – **maximum in mid-afternoon**
  - LST diurnal amplitude is larger over drier areas, and decreases over vegetated areas (plants can control their own temperature through evapotranspiration)



# Land Surface Temperature (LST)

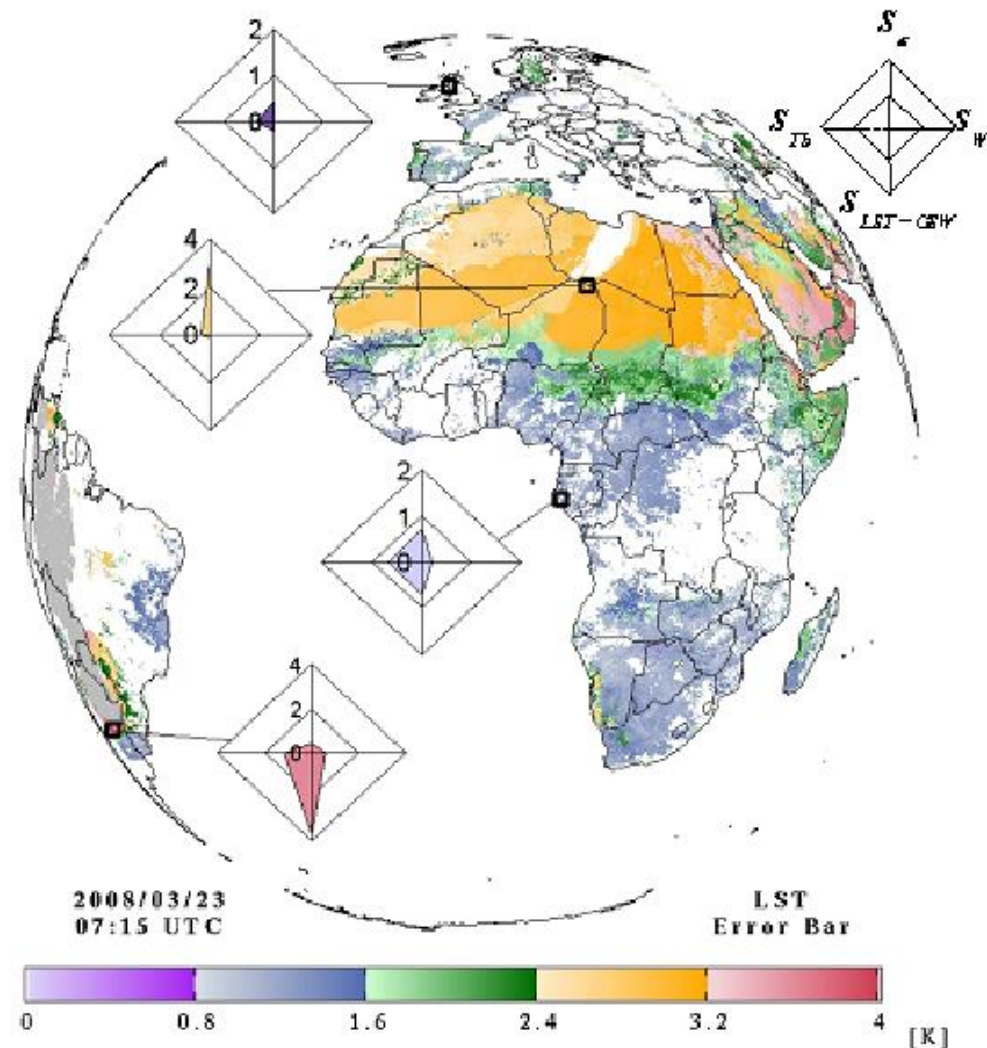
Validation method: in situ/ MODIS LST



# LST Uncertainties Bars

LST fields are distributed along with realistic estimations of the respective error bars on a pixel-by-pixel basis:

Allows users to make the ultimate decision on the applicability of the product.



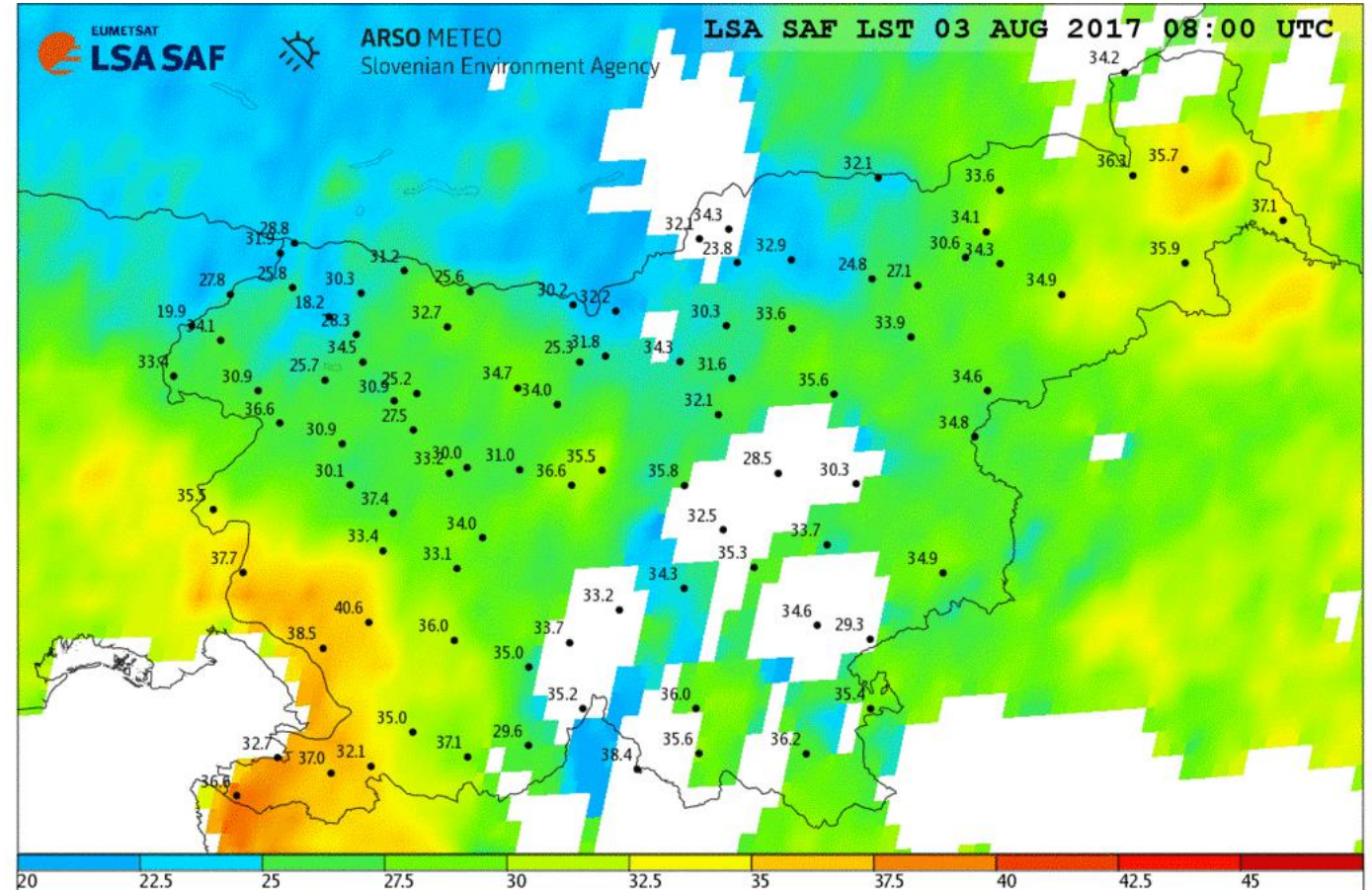


# Early august 2017 heat wave over Southern Europe

Severe heat wave that the media referred to 'Lucifer': in many parts of Southern Europe temperatures exceeded 40°C.

The animation shows daytime LSA SAF LST for 3 - 4 Aug 2017 in 30-minute intervals over Slovenia.

Observations of maximum daily air temperatures in degree Celsius are superimposed on the animation.



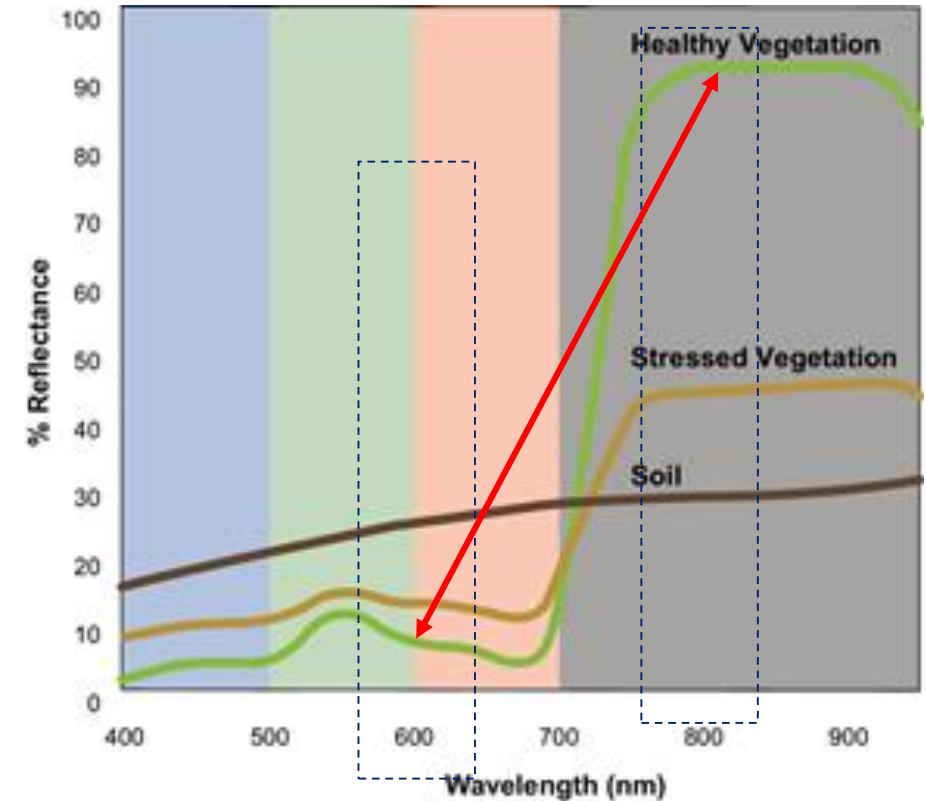
Read more @ <https://landsaf.ipma.pt/en/news/news/lucifer-early-august-2017-heat-wave-over-southern-europe/>



# Normalized Difference Vegetation Index (NDVI)

Normalized Difference Vegetation Index (NDVI) evaluates vegetation by estimating the **contrast between near infrared** (which vegetation strongly reflects) and **red light** (which vegetation absorbs).

The different spectral signatures of healthy and stressed vegetation provides information about the status of vegetation.



# Normalized Difference Vegetation Index (NDVI)

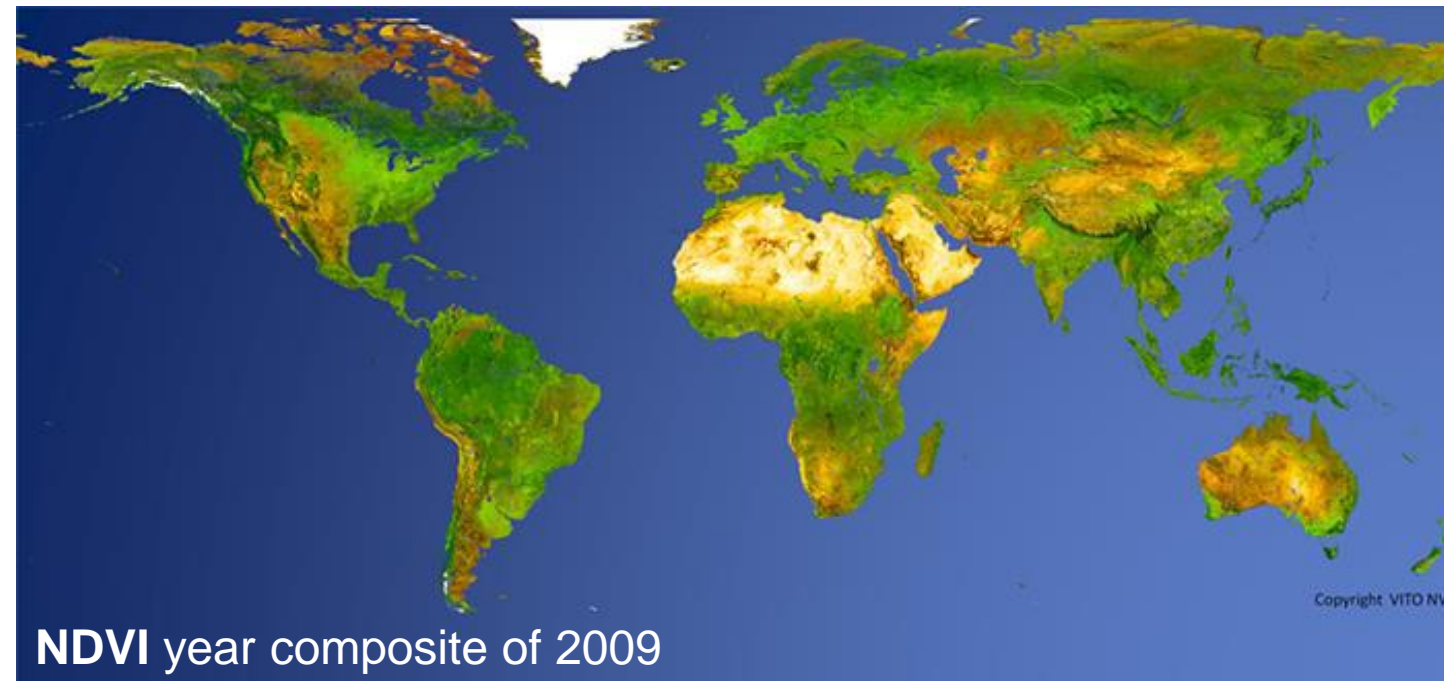
## Algorithm

Top Of Atmosphere (TOA) radiances (**AVHRR/Metop**) in the 0.6 and 0.8  $\mu\text{m}$  channels are converted into surface reflectances (Top-of Canopy, TOC) applying SMAC algorithm (Rahman and Dedieu, 1994); For the atmospheric correction the algo needs information on:

- Water vapour content (ECMWF)
- Aerosol Optical Thickness (Copernicus Atmospheric Monitoring Service (CAMS)) re-analysis
- Ozone info (climatological values based on Earth Probe Total Ozone Monitoring Instrument (EP-TOMS))

### NDVI frequency & temporal coverage

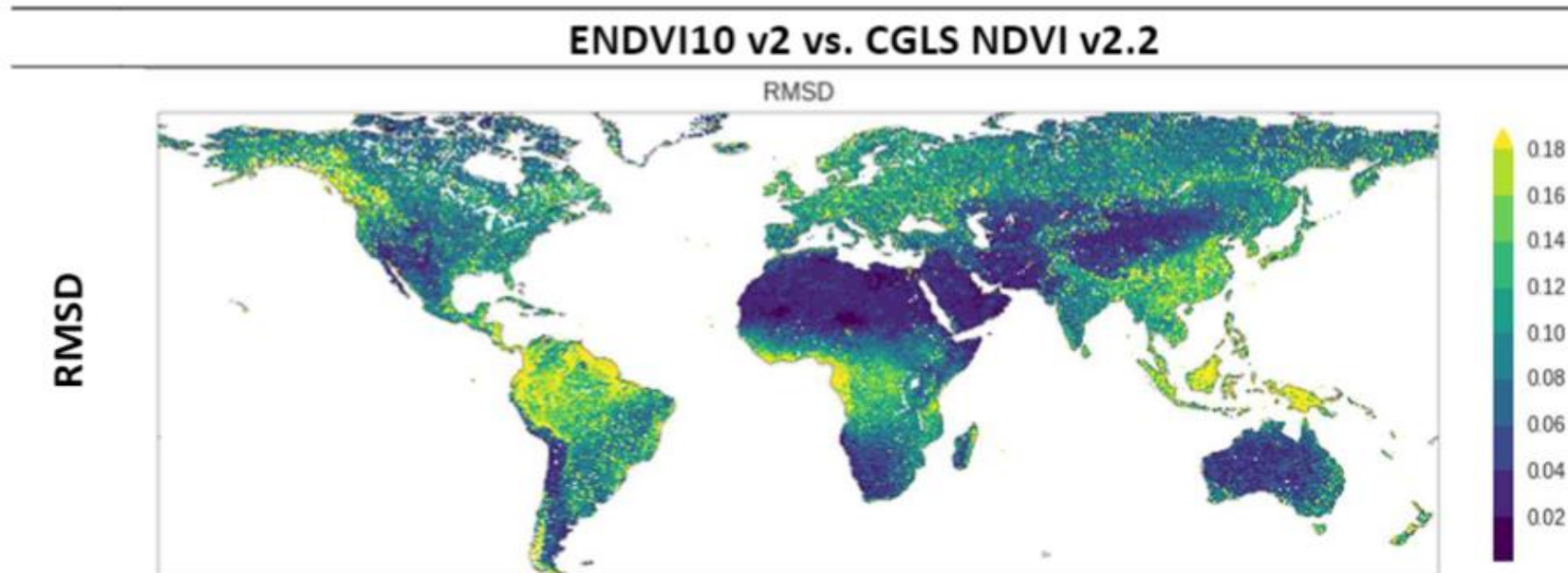
- 10-daily
- since 2007



# Normalized Difference Vegetation Index (NDVI)

## Validation:

- Comparisons with similar products from other platforms
- Comparison with in situ measurements





# Vegetation products suite: FVC, LAI, fAPAR

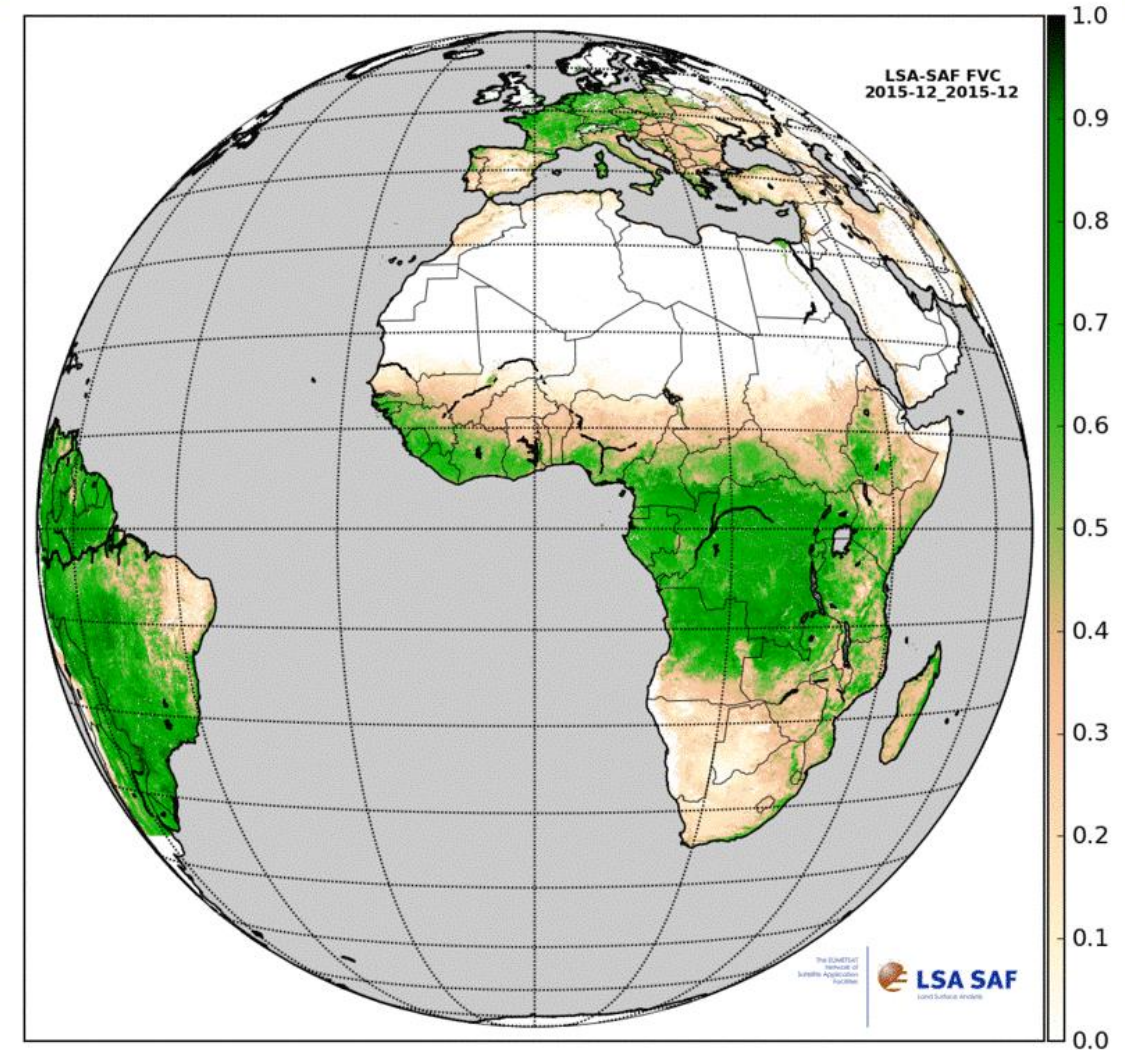
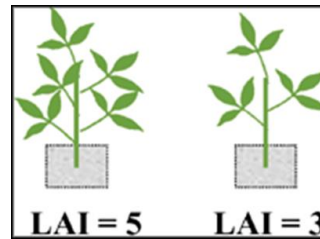
## Fraction of Vegetation Cover (FVC):

- Represents the **fraction of green vegetation** covering a unit area of horizontal soil.



## Leaf Area Index (LAI):

- Accounts for the surface of leaves contained in a vertical column, normalized by its cross sectional area
- For fully and healthy developed canopies, indicates the amount of green vegetation that intercepts (absorbs or scatters) solar radiation

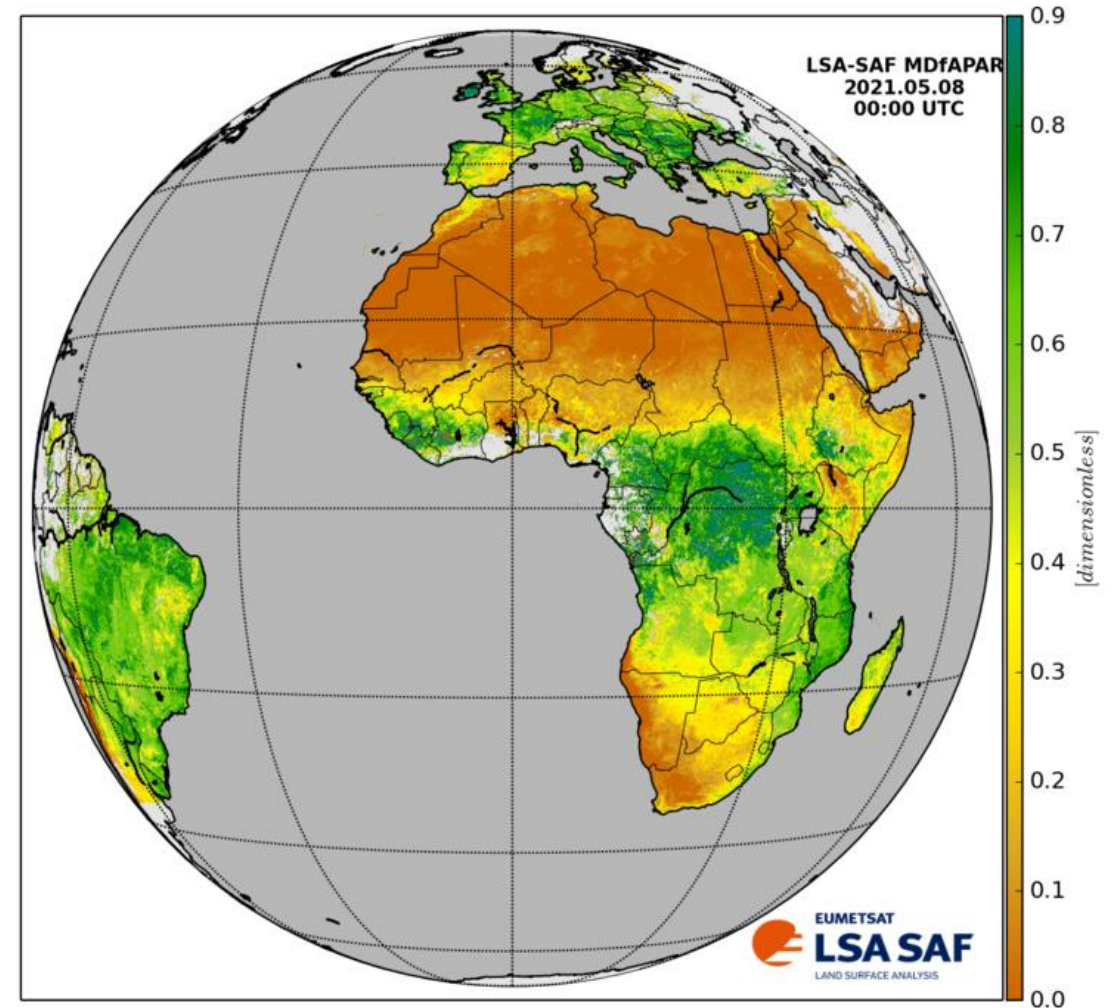


**FVC & LAI define important structural properties of a plant canopy**

# Vegetation products suite: FVC, LAI, fAPAR

## Fraction of Photosynthetically Active Radiation (fAPAR)

- fraction of radiation in the PAR region ( $0.4\ \mu\text{m}$  -  $0.7\ \mu\text{m}$ ) absorbed by the green parts of the canopy for the photosynthesis – indicator of the presence and productivity of alive elements of the canopy.
- Depends on:
  - Canopy structure, Leaf and soil optical properties, Irradiance conditions





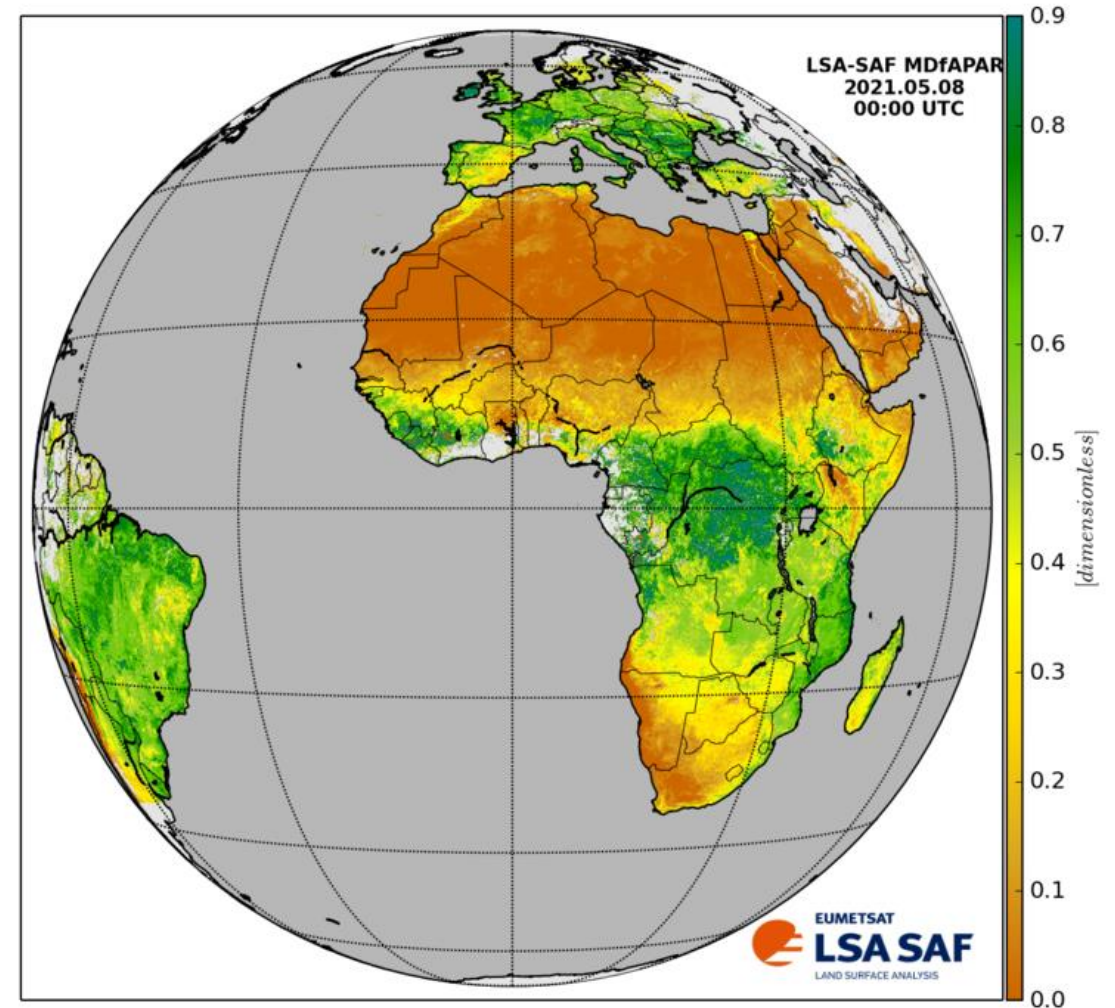
# Vegetation products suite: FVC, LAI, fAPAR

## Fraction of Photosynthetically Active Radiation (fAPAR)

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- Depends on:
  - Canopy structure, Leaf and soil optical properties, Irradiance conditions

## VEGA products frequency & temporal coverage

- daily
- since 2004





# Vegetation products algorithms & validation

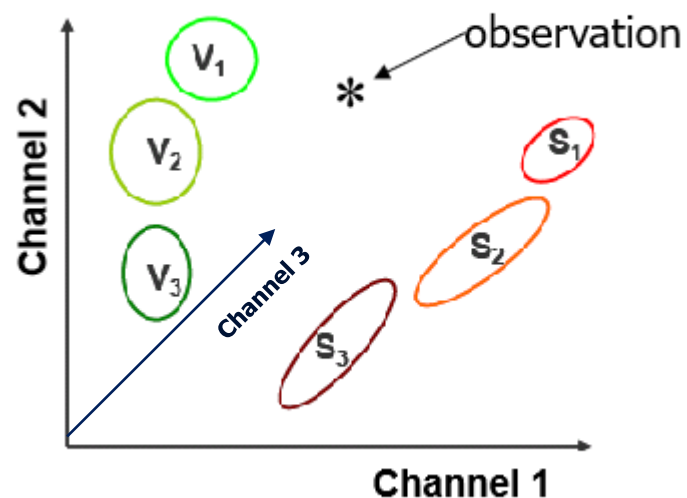
## Algorithms

**FVC & LAI** retrieval relies on an optimized **Spectral Mixture Analysis**

Determines how many constituents are present in an image  
(**V**<sub>1</sub>,..**S**<sub>1</sub>,...)

Identifies the physical nature of each endmember within a pixel

The distances between (\*) and the pairs (**V**<sub>*i*</sub>, **S**<sub>*i*</sub>) give the fractions of each vegetation and soil type within the scene



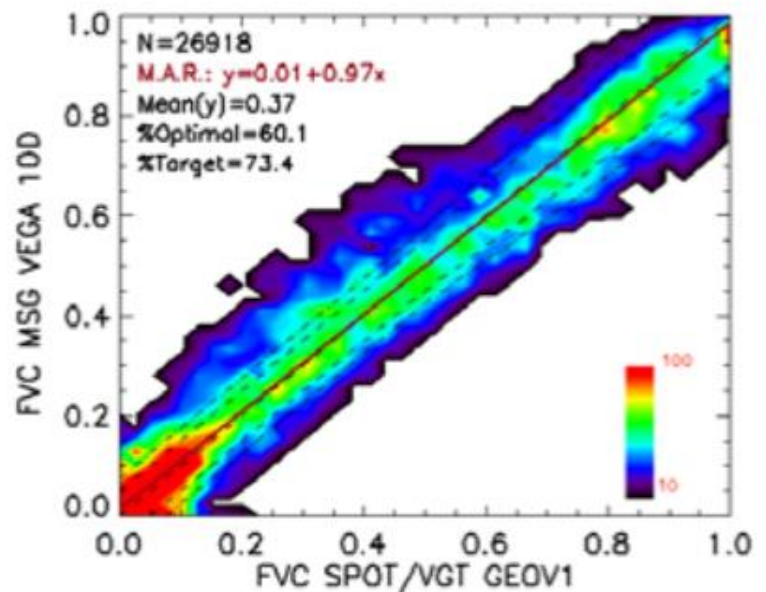
⇒ the pure types, **V**<sub>*i*</sub> and **S**<sub>*i*</sub> for **each pixel** are obtained by the **prevalent Land-cover**

**fAPAR** is derived from an NDVI-like vegetation index

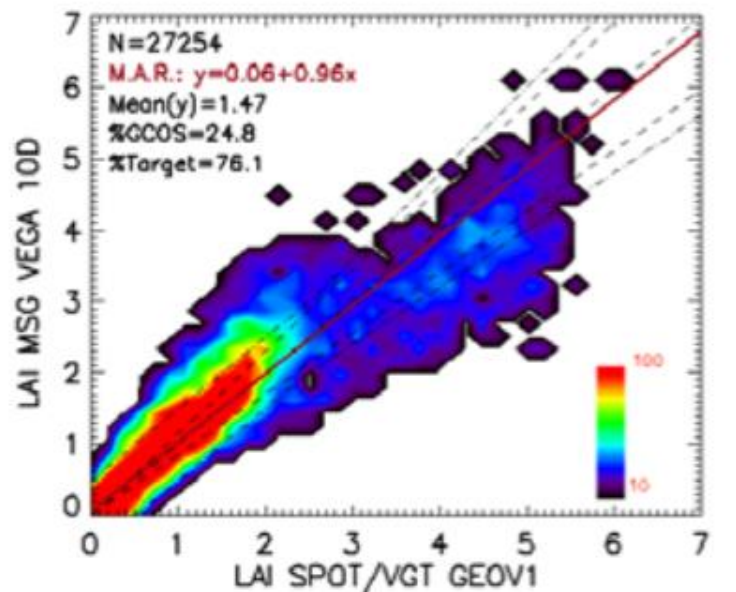
# Vegetation products algorithms & validation

## Validation:

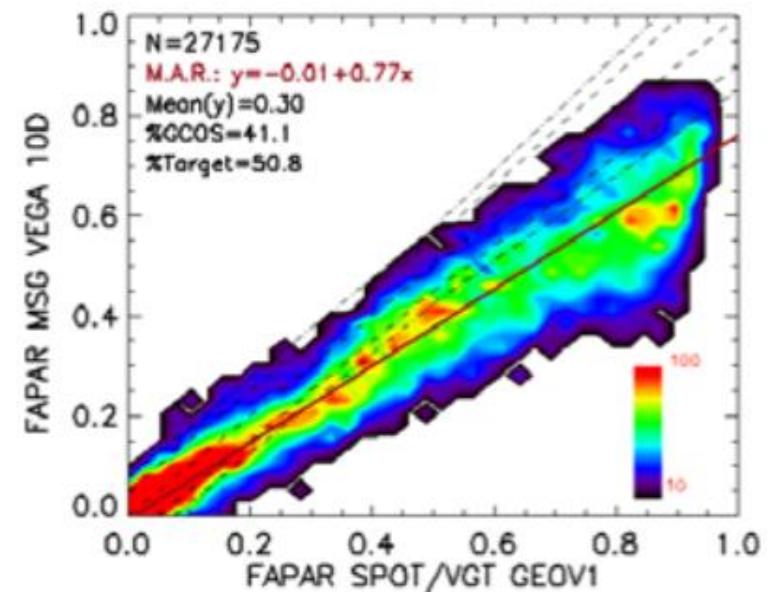
- Comparisons with **similar** parameters from other satellites;
- Comparisons with **in situ data**;



$R^2=0.91$  RMSE=0.09 (25.7%) B=0.003 (0.7%) S=0.09



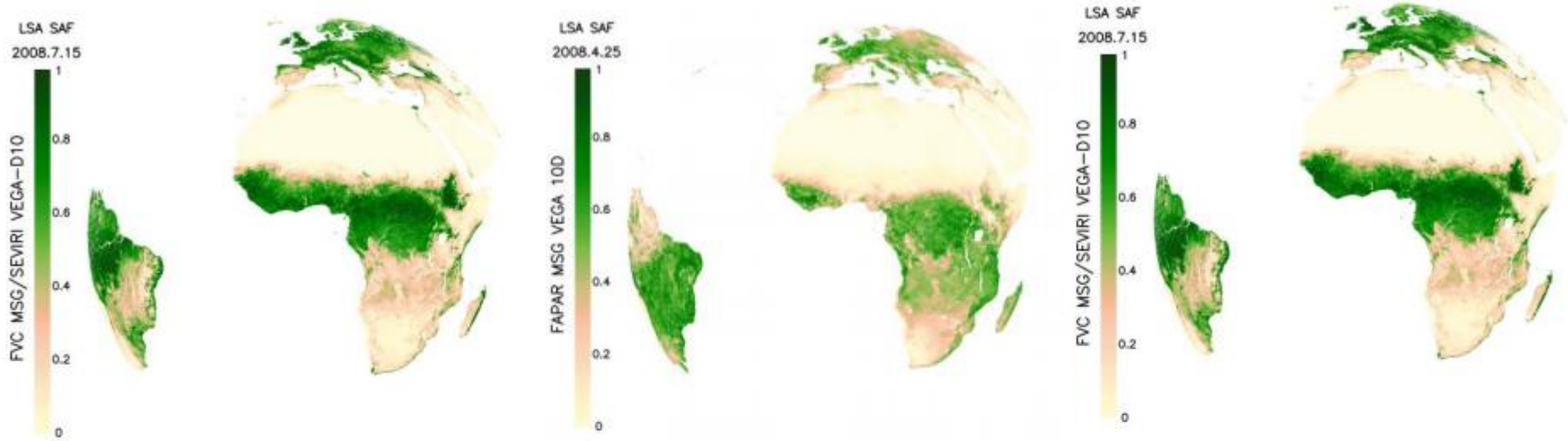
$R^2=0.80$  RMSE=0.72 (48.9%) B=0.005 (0.3%) S=0.72



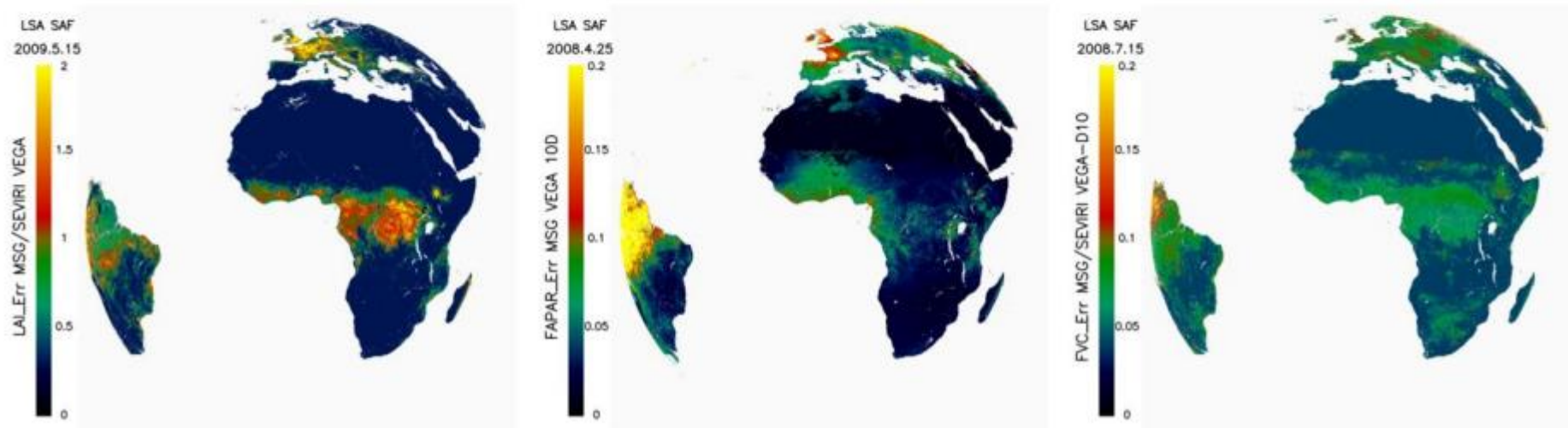
$R^2=0.87$  RMSE=0.16 (44.9%) B=-0.102 (28.7%) S=0.12

# Vegetation products Uncertainties Bars

Product Field



Uncertainties Estimates

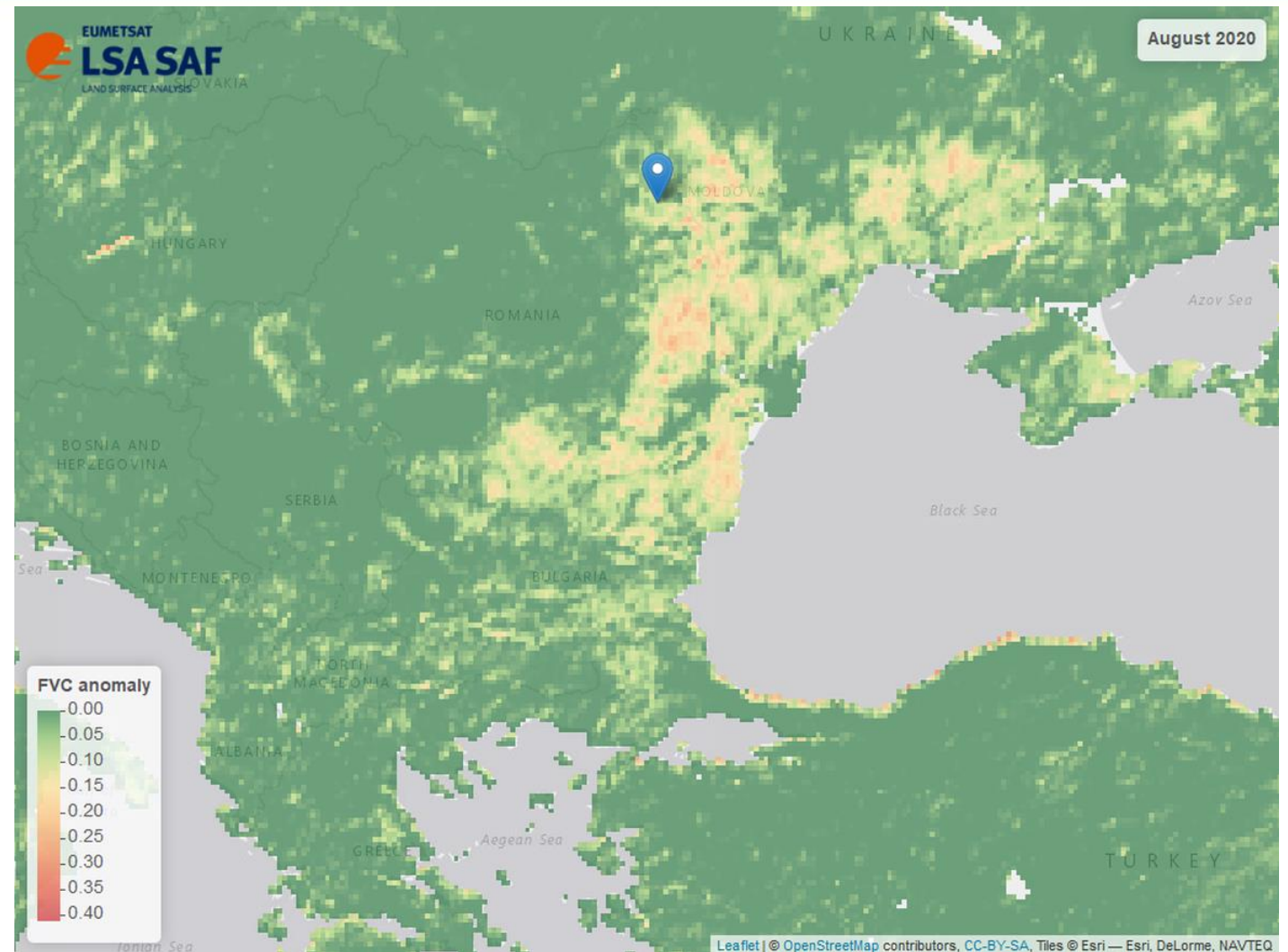




# Drought in SE Europe in August 2020

The map shows FVC anomalies for **August 2020**, as compared to its average in 2004-2017.

The regions of Bulgaria, eastern Romania and Moldova show the most extreme negative values, highlighting the drought that affected this region.

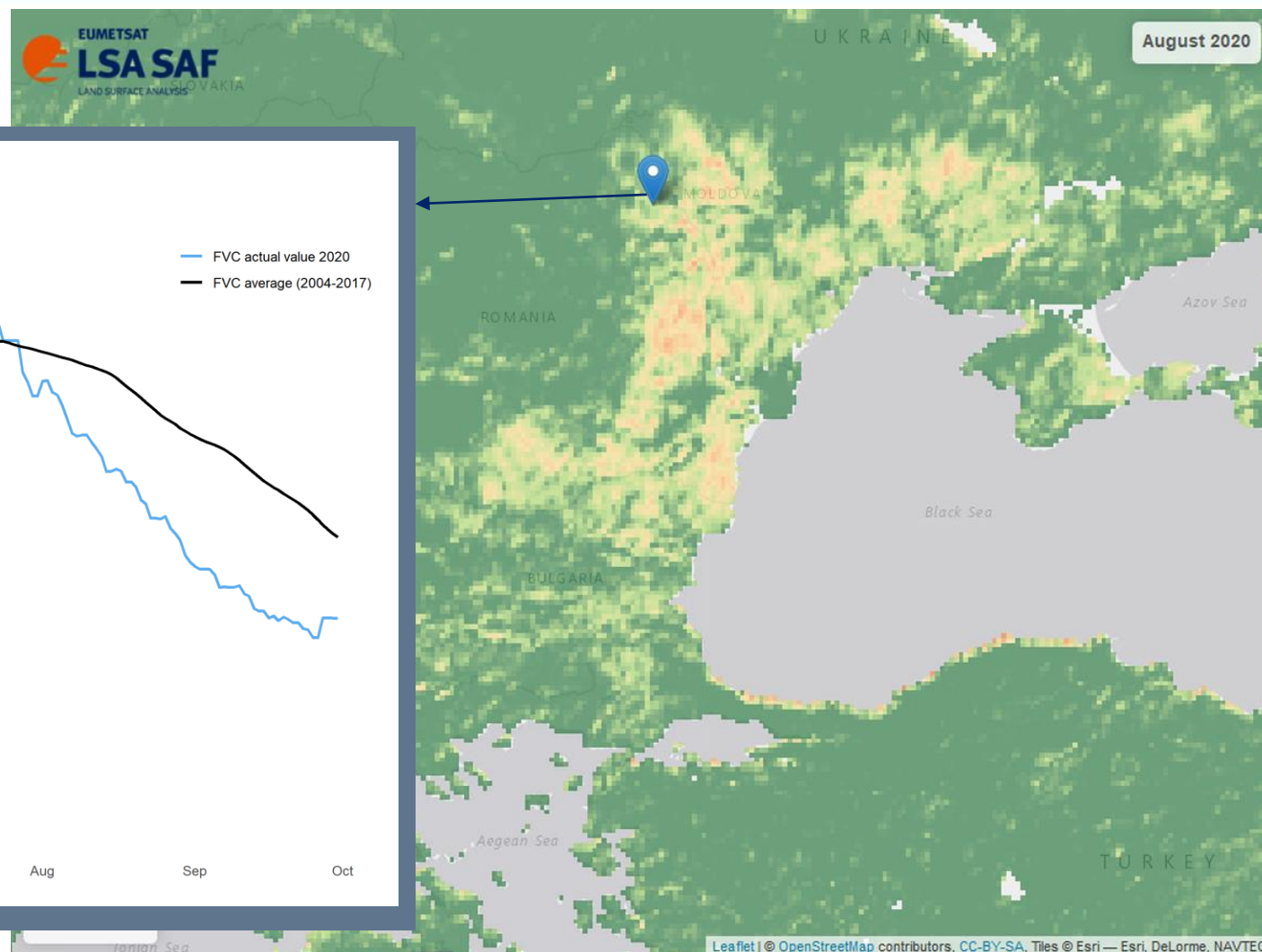
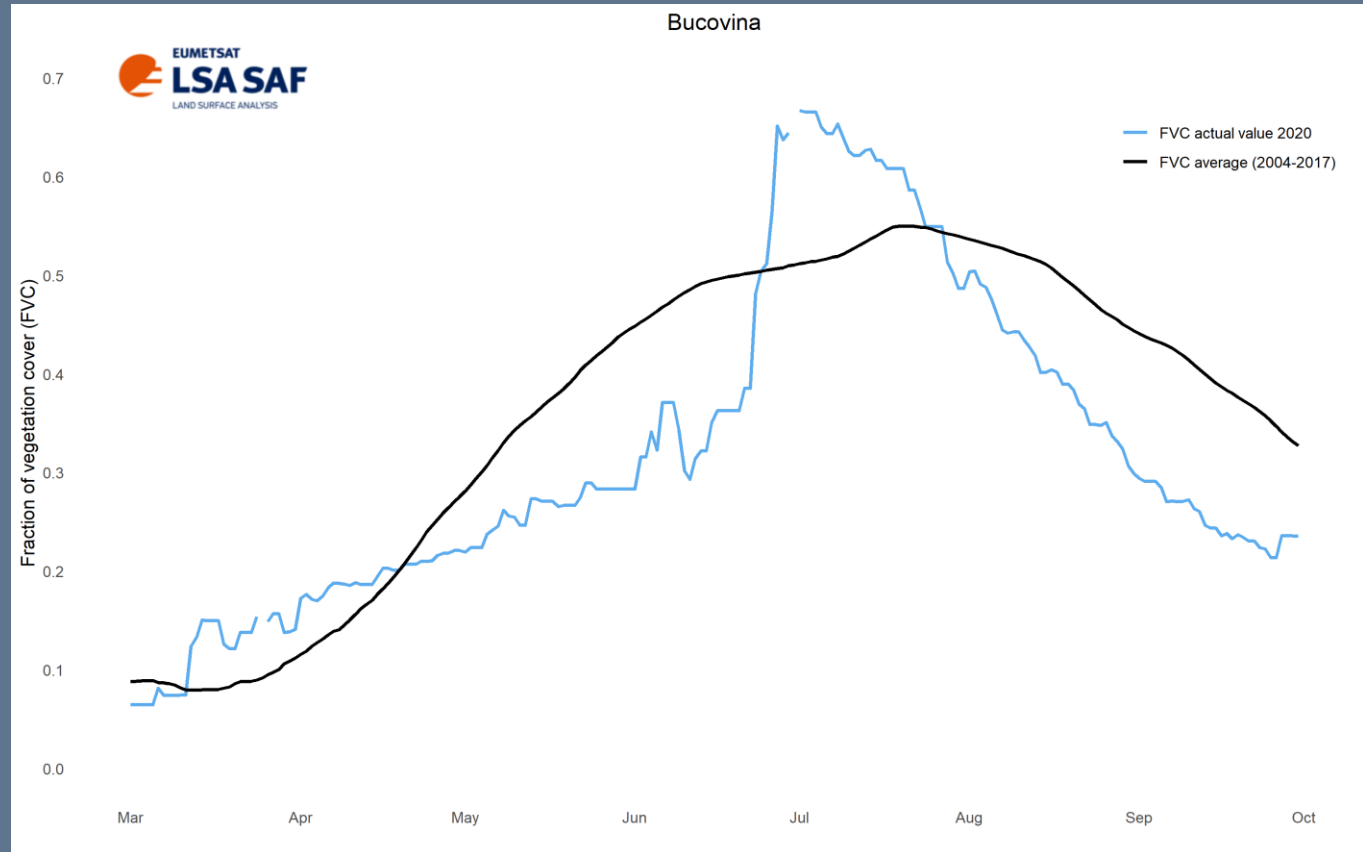


Read more @ <https://landsaf.ipma.pt/en/news/news/drought-in-se-europe-in-august-2020/>

# Drought in SE Europe in August 2020

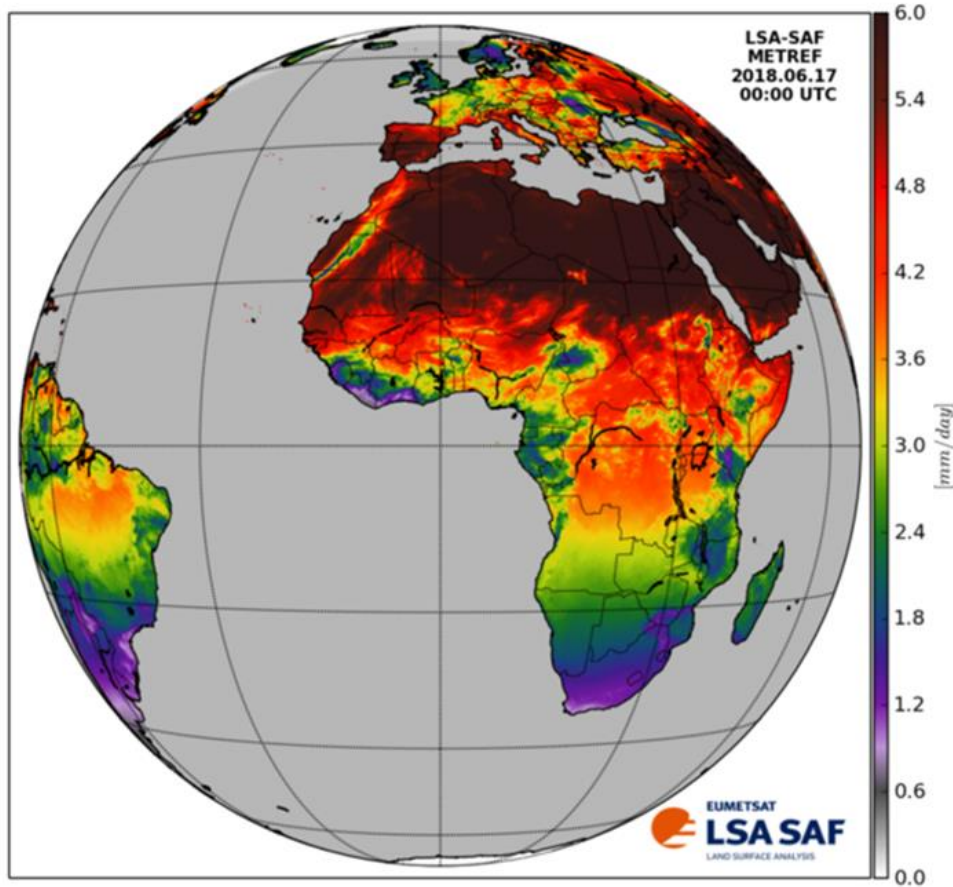
The map shows FVC anomalies for August 2020, as compared to its average in 2004-2017

The and nega affect



Source: <https://landsaf.ipma.pt/en/news/news/drought-in-se-europe-in-august-2020/>

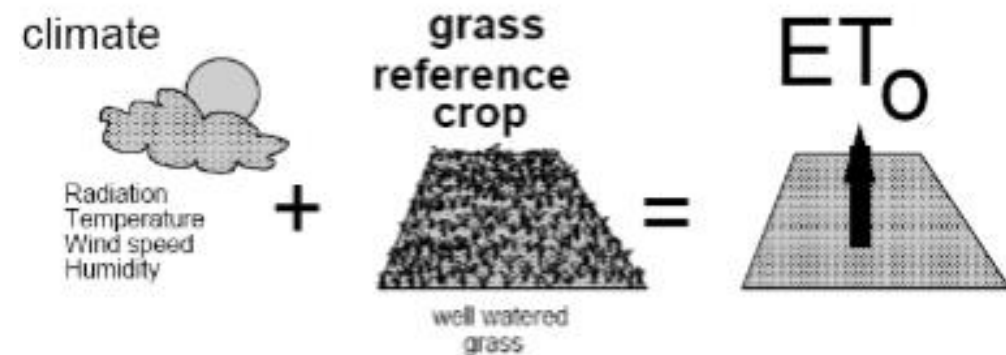
# Reference Evapotranspiration (METREF)



## LSA SAF METREF frequency & temporal coverage

- Daily
- > 2004

**Reference evapotranspiration**, METREF, is the evapotranspiration rate from a clearly defined reference surface, an hypothetical well watered field with green grass.



It is **independent** of the crop type, crop development or management practices.

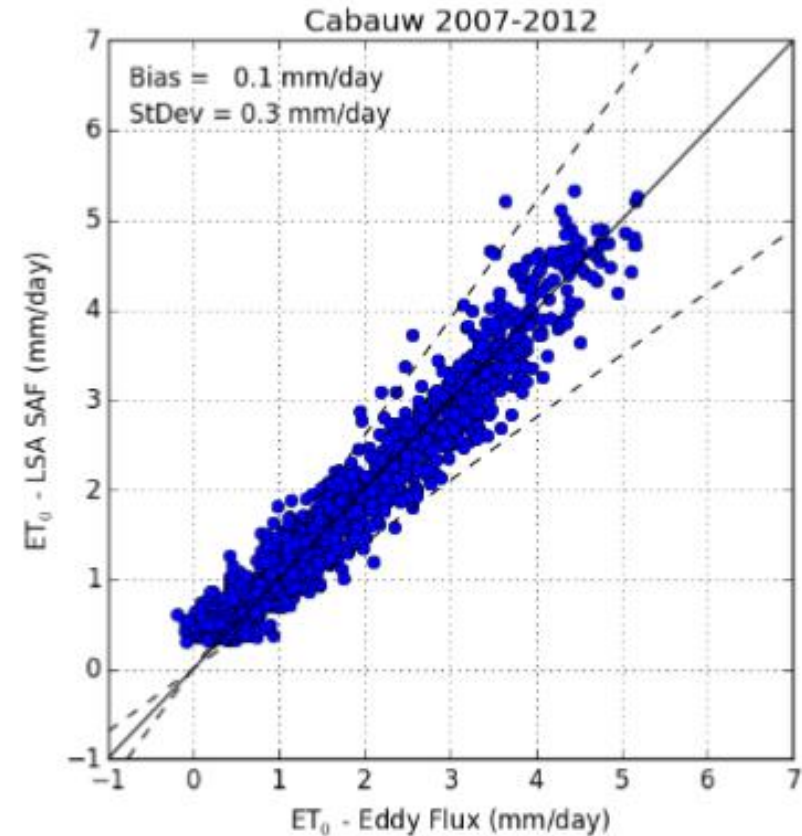


# Reference Evapotranspiration (METREF)

## Retrieval

METREF [mm/day] is estimated from **daily global radiation** derived from SEVIRI/MSG, as this is **the main driver of evapotranspiration** over the extensive reference surface.

**Validation method:** comparison with *in situ* measurements





# Explore the D&V Monitoring Data Cube!

