

# **The EUMETSAT Satellite Applications Facility on Land Surface Analysis LSA SAF**

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# Outline

- The EUMETSAT LSA SAF
- Products and Services
- Applications
- Training & Outreach
- Service Continuation / Evolution

## EUMETSAT Satellite Applications Facility on Land Surface Analysis

- Part of EUMETSAT Ground Segment
- Aims to develop algorithms that allow an effective use of MSG and EPS data related to
  - LAND
  - LAND-ATMOSPHERE Interactions
  - BIOSPHERIC Applications
- Generates, Archives & Distributes **Satellite Products** in Near Real Time (up to 3h after last obs) and Off-line
- Consortium – 8 Institutes / 6 countries



- Reviewed (~annually) by technical and scientific panels

# LSA SAF – Family of Products

## Surface Radiation

**LST**

**↓LongWave Flux**

**↓ShortWave Flux**

**Albedo**

## Vegetation

**State**

**Fraction Veg Cover**

**LAI**

**fAPAR**

**NDVI**

**Water stress**

**Evapotranspiration**

**Reference Evapot**

**Wild fires**

**Fire Detection**

**Fire Radiative Power**

**Fire Risk (Europe)**

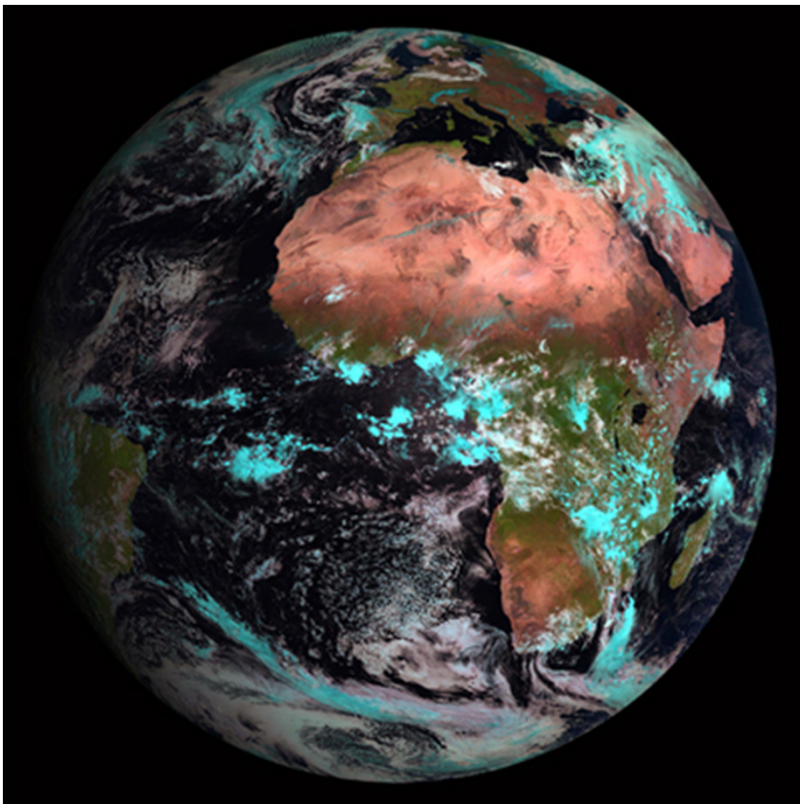
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**MSG & Metop platforms**

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## Meteosat Second Generation

- Geostationary orbit
- Nominal sub-satellite point at 0° long



## Main focus of LSA SAF until present

### Spinning Enhanced Visible and Infrared Imager - SEVIRI

- explore 96 observations /day (every 15 min) ...
- 12 channels ...
- at 3 km at nadir

All products have a quality flag and/or error bar field associated

All products have a Product User Manual and a comprehensive Validation Report

Full MSG disk

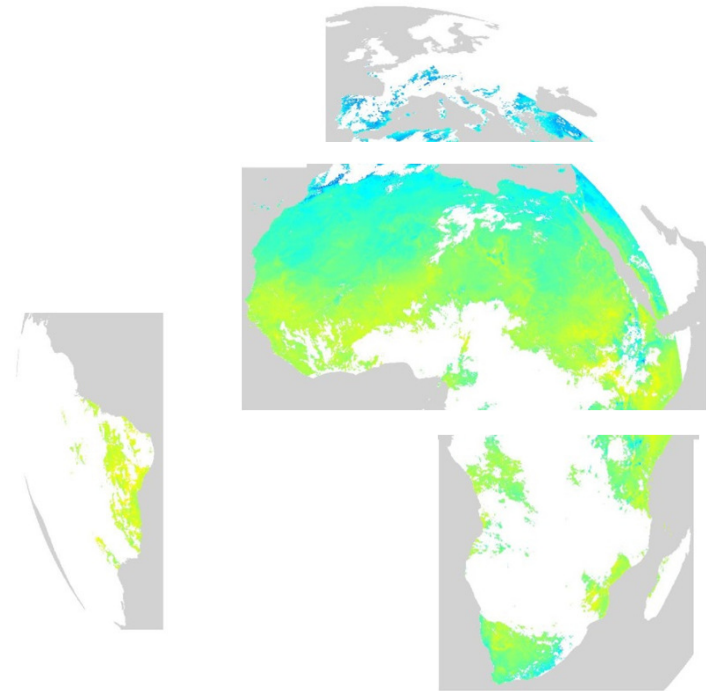
- Europe
- Northern Africa
- Southern Africa
- Southern America

SEVIRI resolution

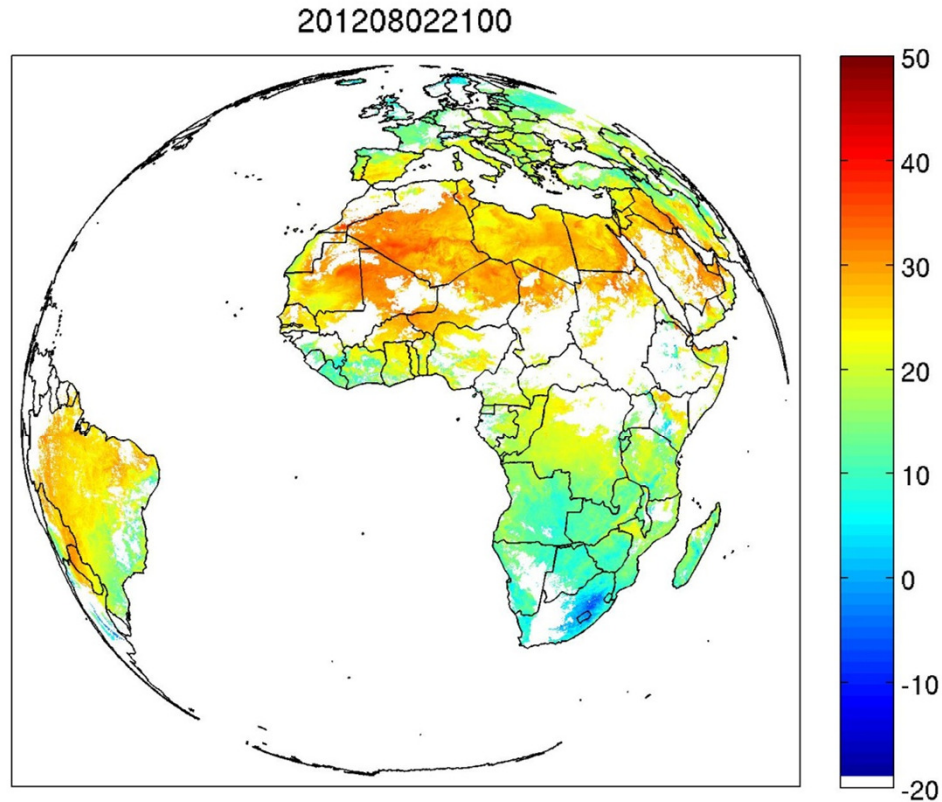
Variable time resolution

-15 min to 10 days

EPS products generation started



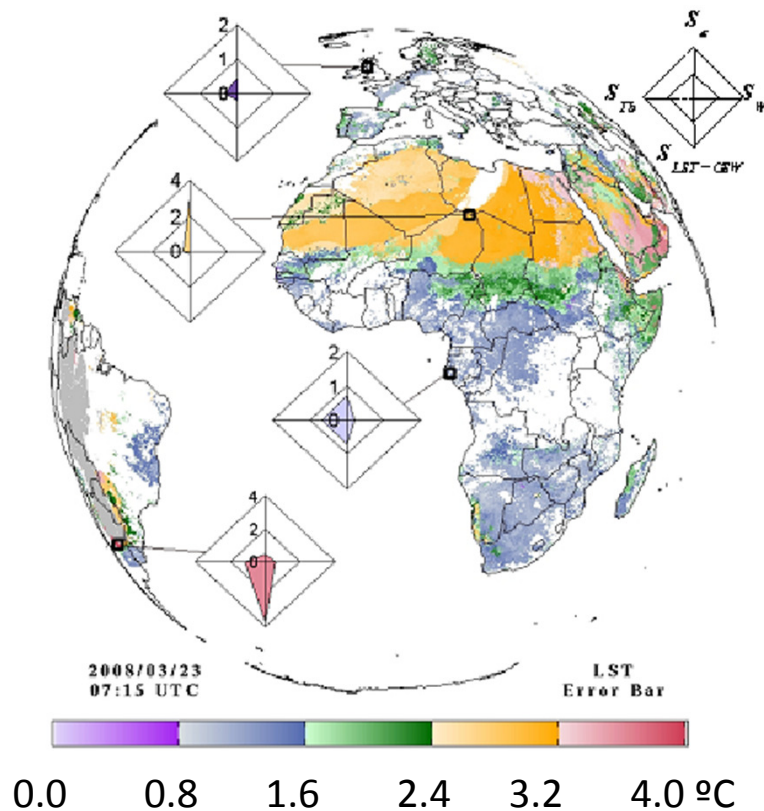
# Land Surface Temperature



- ✓ 15-min
- ✓ 3 km at sub-satellite point
- ✓ clear sky pixels
- ✓ NRT (EUMETCast)
- ✓ Off-line

# Land Surface Temperature

## LST Error Bars



Masked out  $\delta LST > 4K$

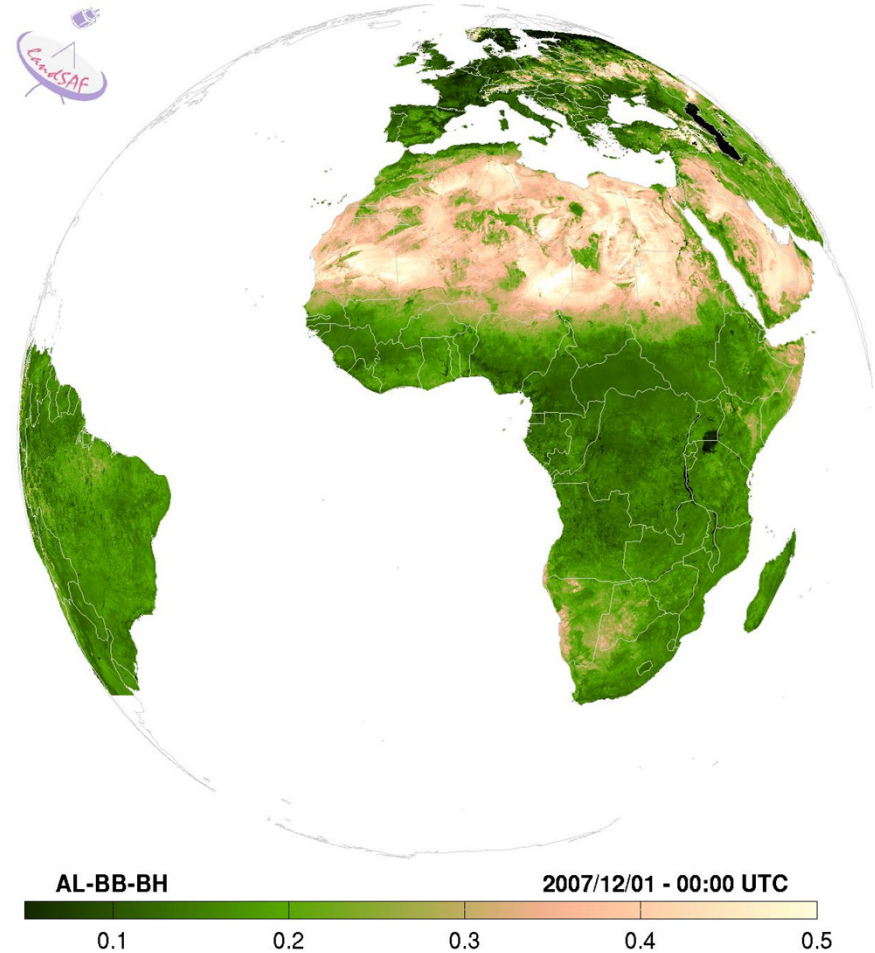
And error bars estimated taking into account:

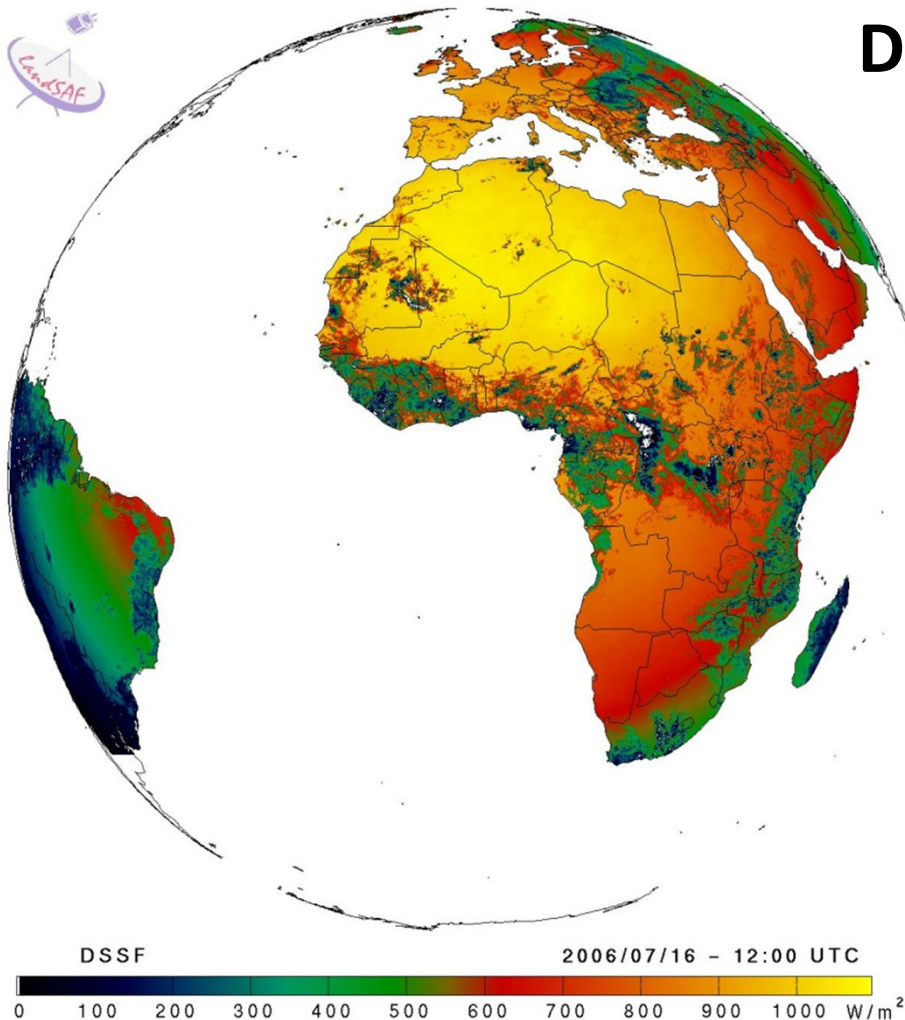
- ✓ Uncertainty of the GSW regressions
- ✓ Propagation of input uncertainties:
  - Emissivity
  - Sensor noise
  - TCWV ECMWF forecasts



# ALBEDO

- *Spatial Resolution:*  
SEVIRI original resolution  
3 km at nadir
- *Temporal Resolution:*  
Daily & 10-daily
- *Area Coverage:*  
SEVIRI disk
- *Error bars*
- *Available since:*  
2005

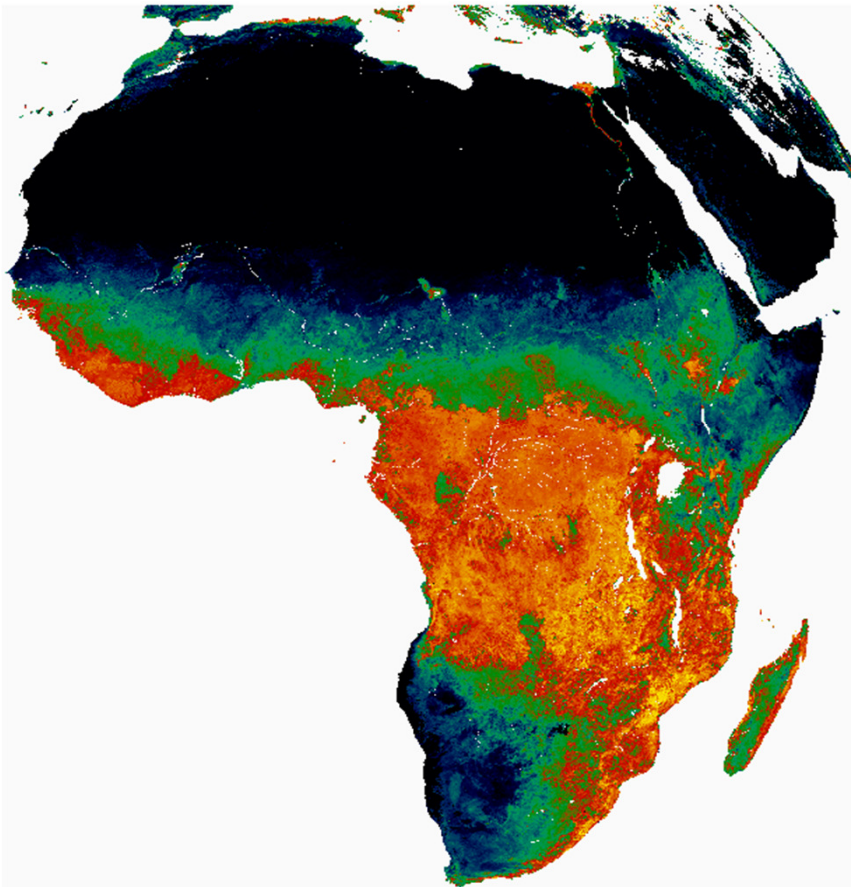
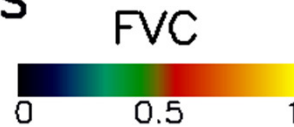




## Downward Short-wave (solar) radiation at the surface

- ✓ 30-min and daily products
- ✓ 3 km at sub-satellite point
- ✓ NRT (EUMETCast)
- ✓ Off-line

MSG VEGA PRODUCTS  
20080111



## Fraction of Vegetation Cover

- ✓ Daily and monthly products
- ✓ 3 km at sub-satellite point
- ✓ NRT (EUMETCast)
- ✓ Off-line

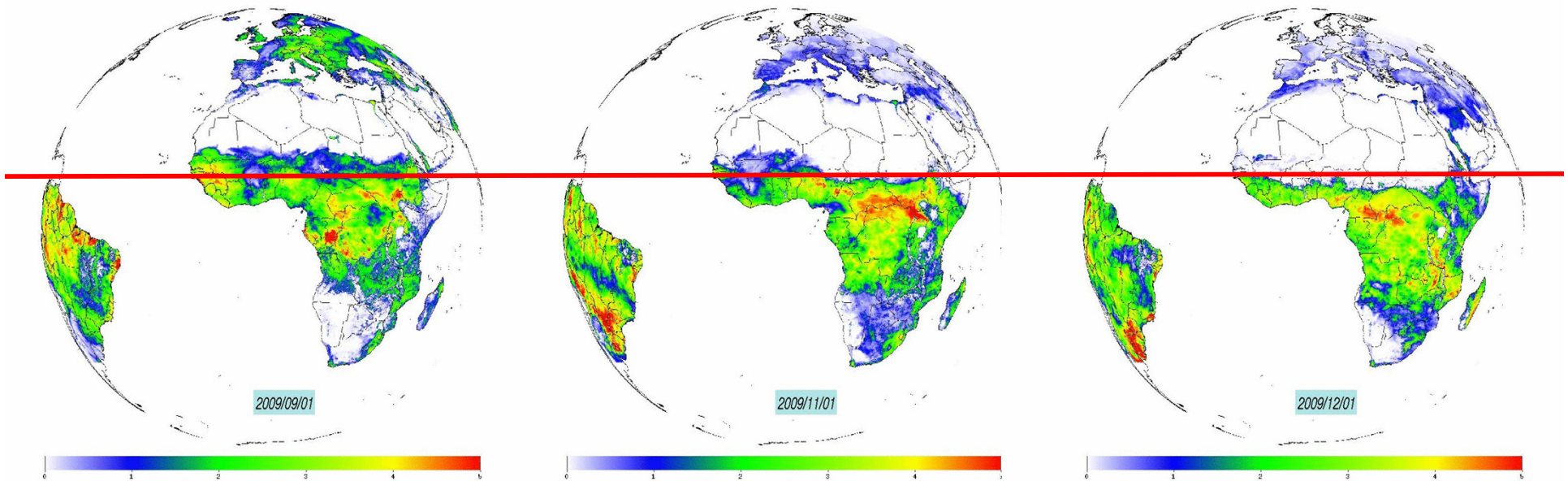
# Evapotranspiration

Based on Sfc Energy Balance with Radiation products (and VEGA) from LSA SAF

**September 2009**

**November 2009**

**December 2009**



✓ 30-min and daily products

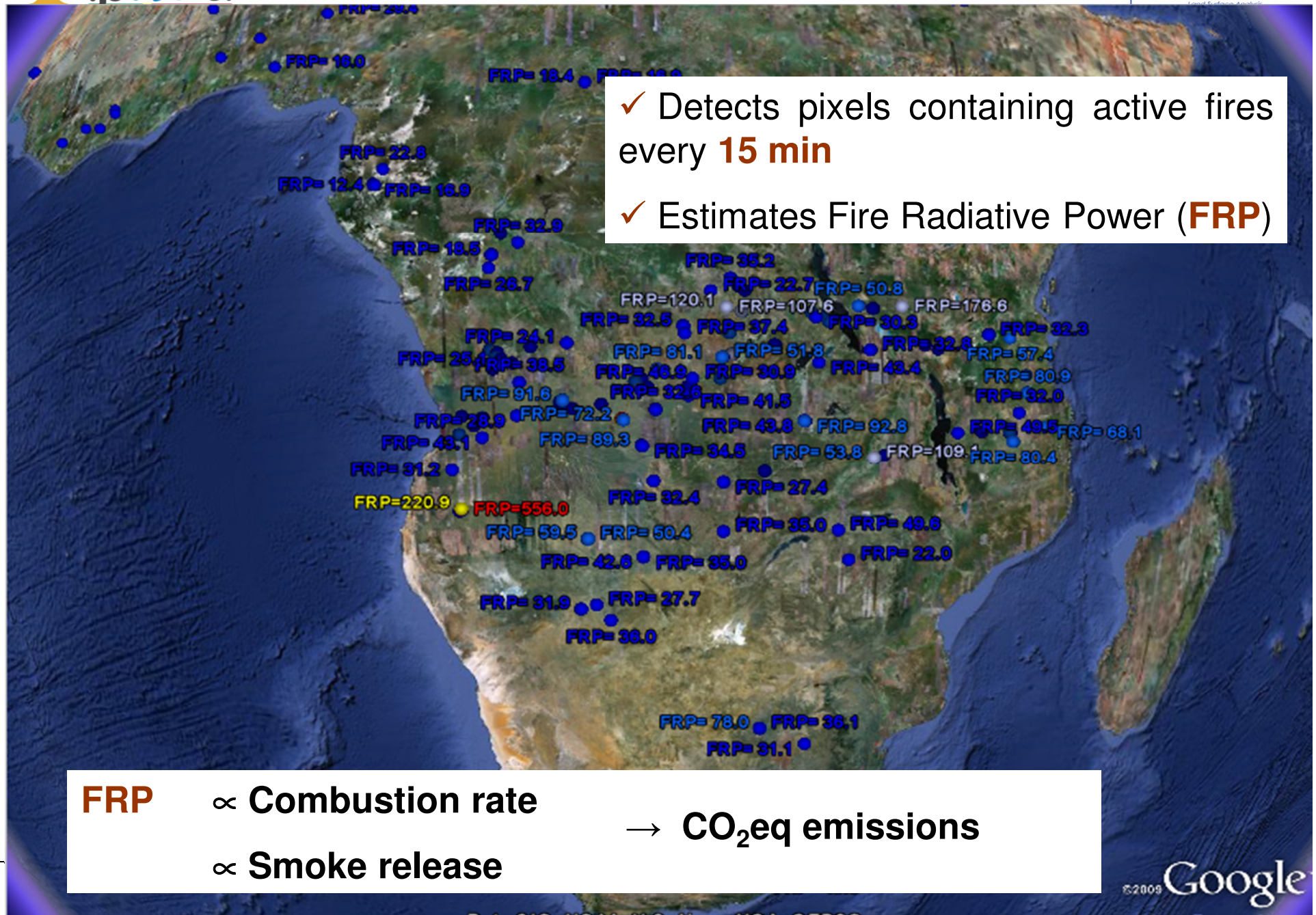
✓ 3 km at sub-satellite point

✓ NRT (EUMETCast)

✓ Off-line



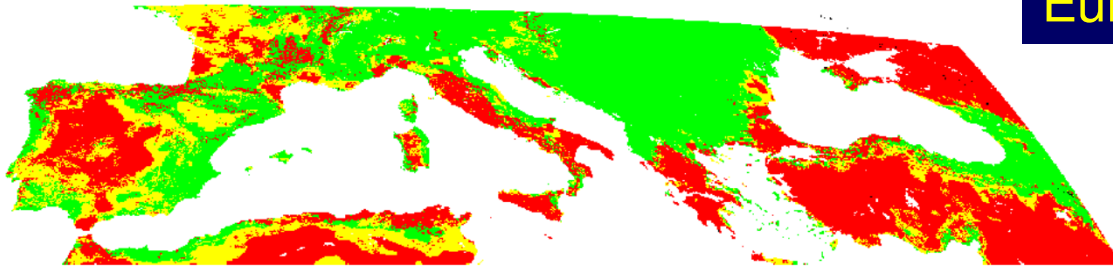
- ✓ Detects pixels containing active fires every **15 min**
- ✓ Estimates Fire Radiative Power (**FRP**)



**FRP**  $\propto$  Combustion rate  $\rightarrow$  CO<sub>2</sub>eq emissions  
 $\propto$  Smoke release

# Wild Fires

23 Jul 2008



**Risk of Fire over Southern Europe**

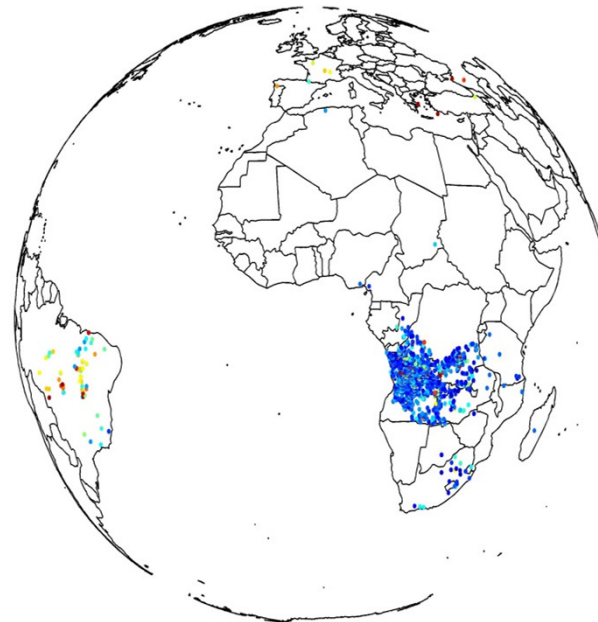
**Forecast of Risk: 24h – 78h**

**Fully consistent with ...**

**Fire Detection &  
Monitoring**

Every 15-min (SEVIRI)

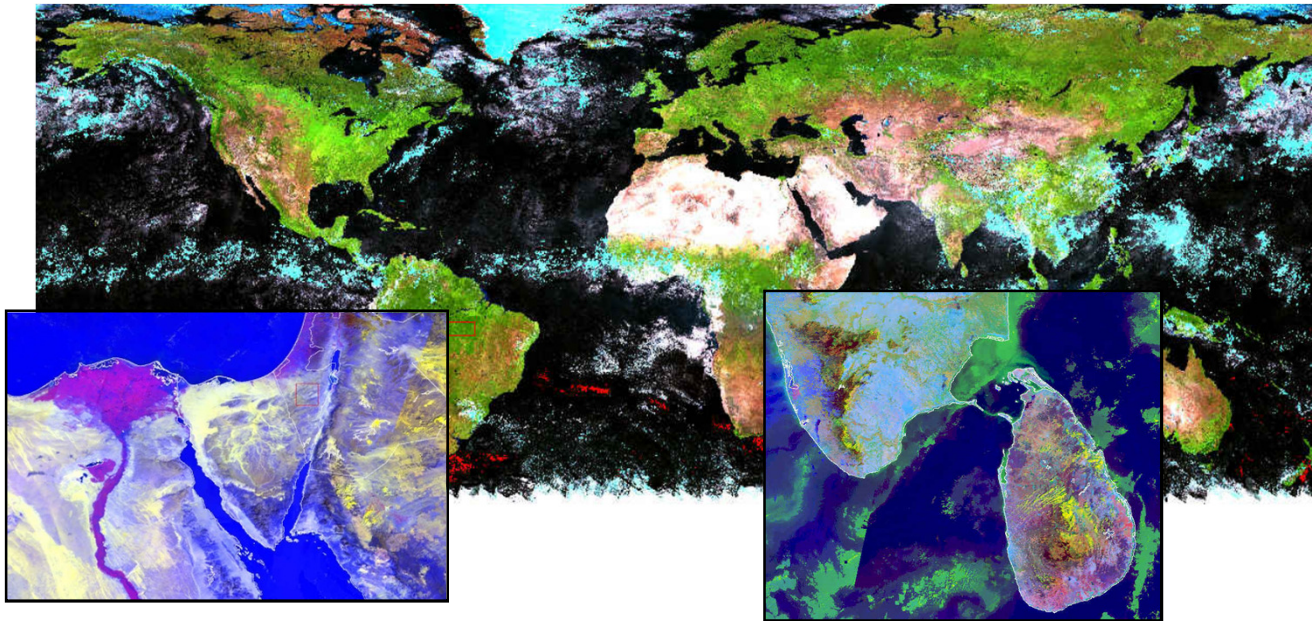
23 Jul 2008 14 UTC





# MetOp

## 10-day NDVI from AVHRR/Metop



**Example of a Global S10-composite derived from METOP-AVHRR,  
with zoom on two regions: the Nile delta and Sri Lanka**

# LSA SAF – Product Validation

## GENERAL APPROACH

- **Validation**: Information on products compliance with user requirements
- Intercomparison with other satellite derived similar products
  - ✓ MODIS
  - ✓ AATSR
  - ✓ CERES
  - ✓ ...
- Comparison with **Ground Observations**
  - LSA SAF/ KIT sites (Souther Portugal; Namibia; Senegal)
  - Established Networks (e.g., BSRN, Fluxnet)
  - Field Campaigns (e.g., AMMA)
- Comparison with **Model fields**

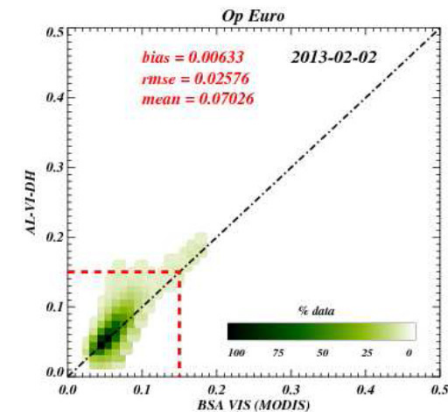
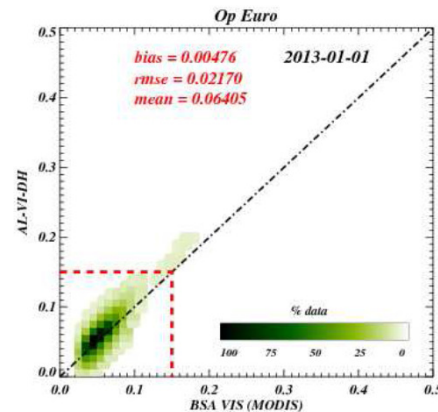
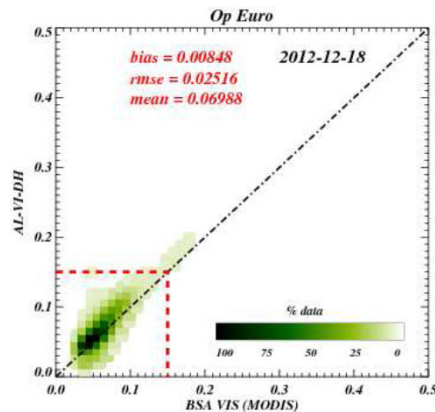


## As part of Product Development:

Validation Consolidated Results in Validation Reports  
( & Scientific Articles)

## Operational Products - regular Quality Assessment

SEVIRI VIS Albedo



MODIS Black-Sky VIS Albedo

# Outreach & Training

## Regular Workshops

- ✓ LSA SAF team presents work on product development & validation
- ✓ Users are invited to report on applications and ...
- ✓ to discuss product/service requirements

## Training

- ✓ e-learning modules
  - <http://www.eumetrain.org/data/3/36/index.htm> (Vegetation)
- ✓ Courses (in cooperation with EUMETSAT)
  - 2-6 Nov 2009 – Remote Sensing over Land Surfaces, Monzambique (in Portuguese)
  - 2011 – Land SAF Week  
([http://eumetrain.org/events/lsasaf\\_week\\_2011.html](http://eumetrain.org/events/lsasaf_week_2011.html))
  - 19-23 Nov 2012 – Remote Sensing over Land Surfaces, Niger (in French)

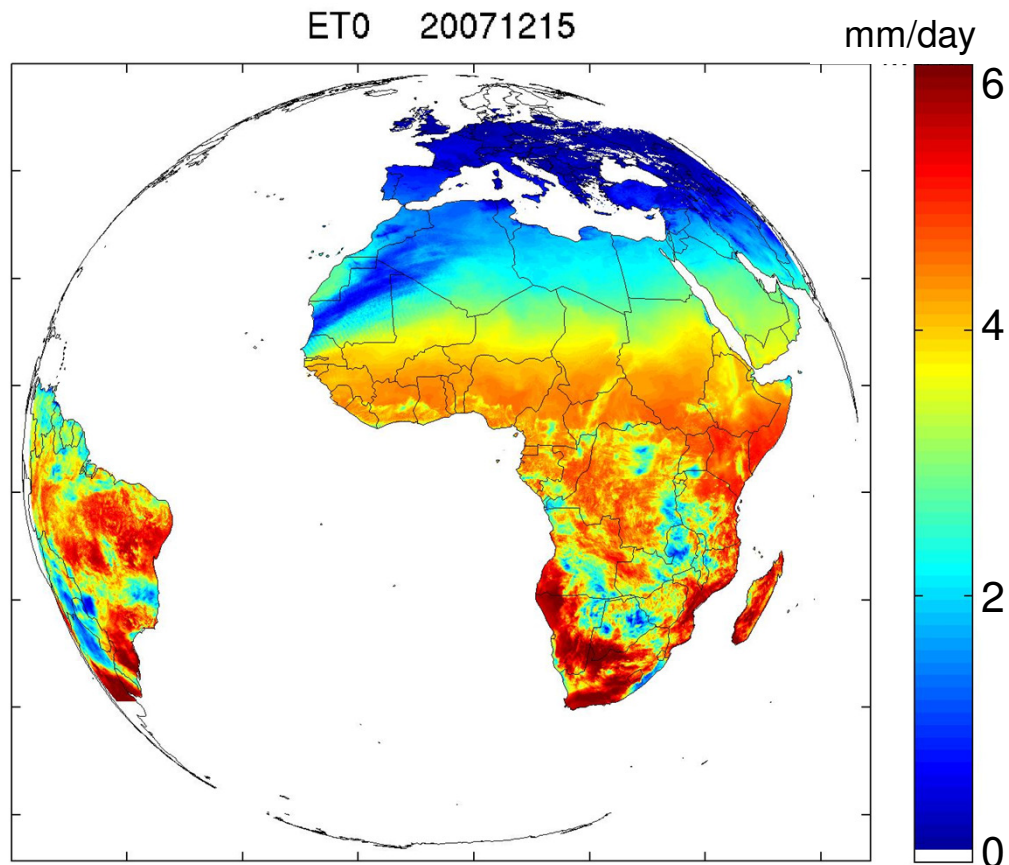
# LSA SAF Products

## Applications

# Reference Evapotranspiration

$ET_0$

Application of Solar Radiation,  
DIDSSF (please see poster!)



- ✓ Daily
- ✓ 3 km at sub-satellite point

$$ET = K_c ET_0$$

Irrigation Needs

Crop Factor  
(FAO)

# Land Surface Temperature **Application**

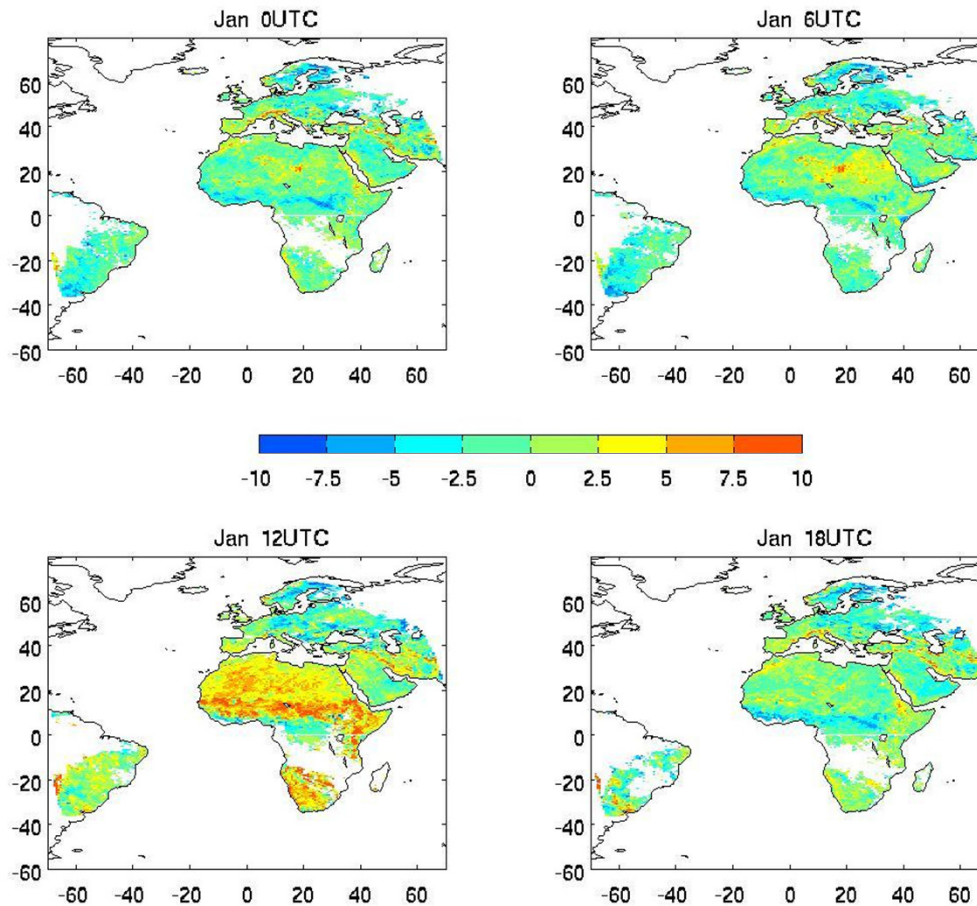
Assessment of ECMWF Land Surface Model:

Impact of changes in model vegetation

# LST and Models

LST\_SEVIRI – ECMWF skin Temp 1-15 Jan 2009  
(only cases with model TCC < 10% - **always from now onwards**)

2009



- Good agreement of night-time temperatures;
- Underestimation of daily amplitudes – particularly in semi-arid /sparsely vegetated regions.

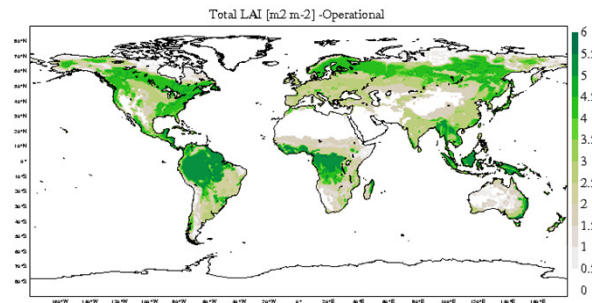
## Suite of forecast experiments

**CTL: Constant LAI**

**LAI\_MOD: monthly climatology LAI - MODIS**

**LAI\_rsmin: LAI MODIS climate + reduction of minimum stomatal resistance**

Boussetta et al., 2011

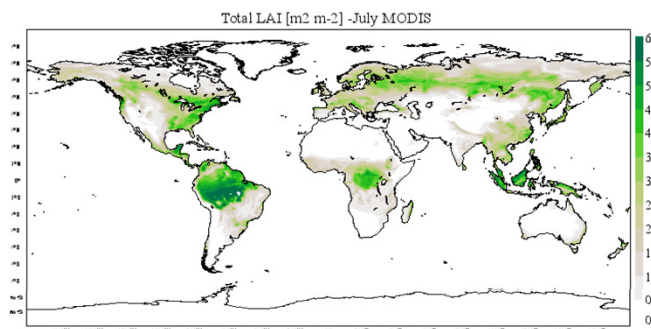
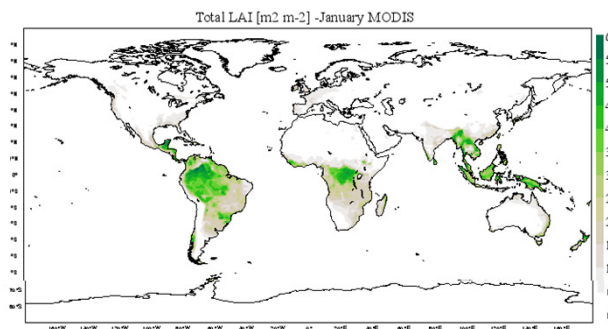


Constant LAI

January

LAI MODIS climate

July

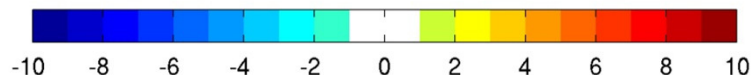
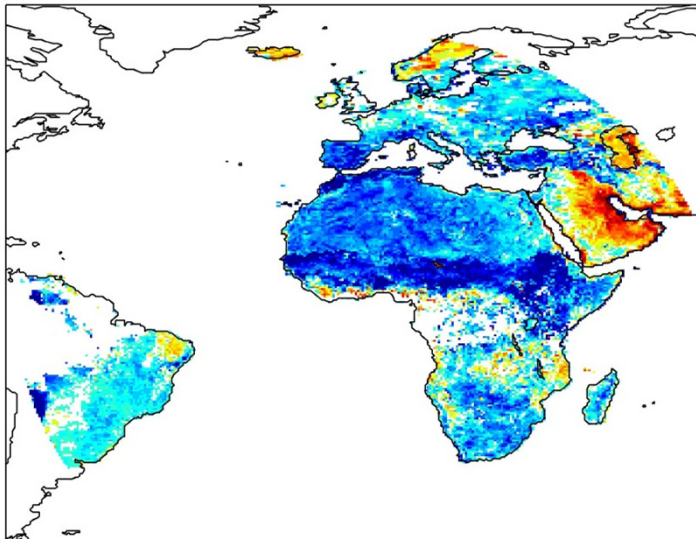




Tsk\_CTL – LST

Control

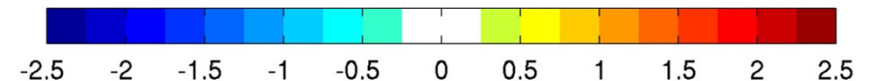
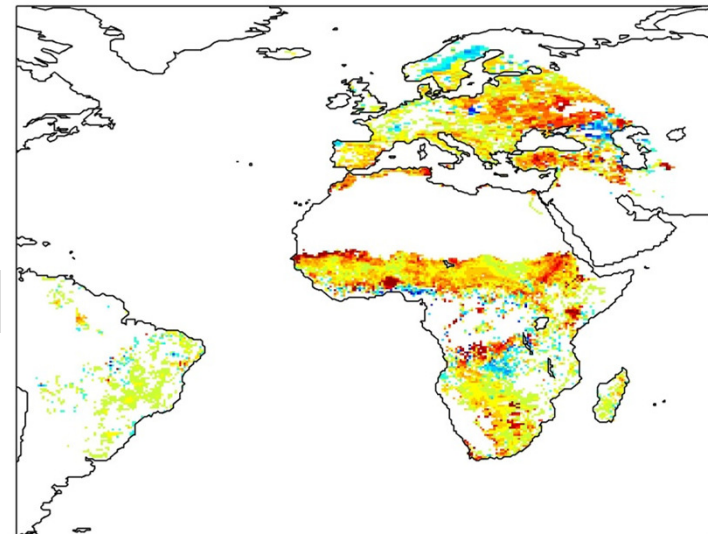
Bias: f7wx MAM-12 UTC



Impact (Changes in Bias)

MODIS LAI

Impact: f87n MAM-12 UTC

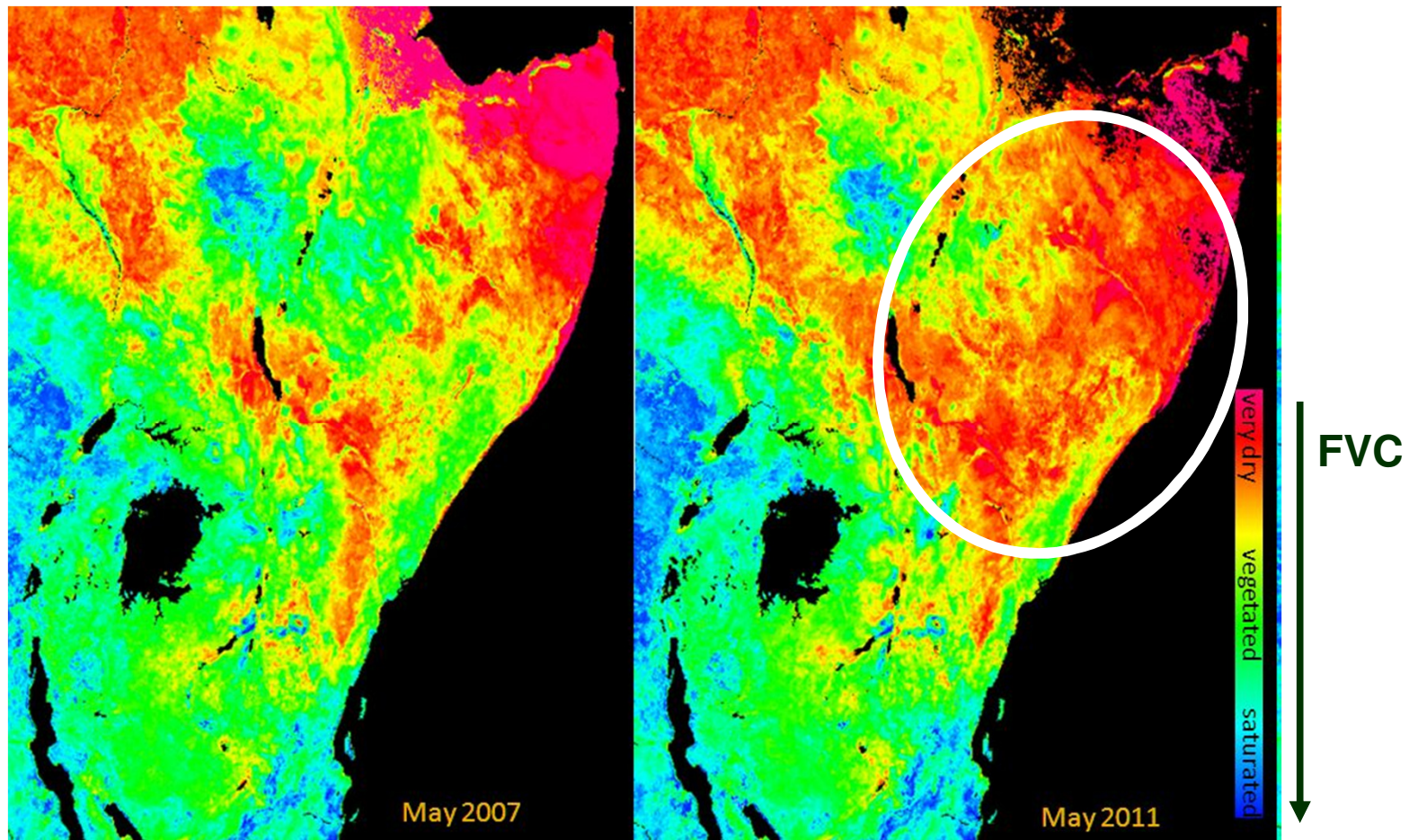


12 UTC

- ✓ There is a positive impact of the MODIS LAI in MAM and JJA. The decrease in stomatal resistance compensates for the decrease in LAI and therefore reduces the impact on LST
- ✓ The impact on skin temperature over Europe is negative in summer (not shown) when the minimum stomatal resistance is reduced for needle-leaf trees.



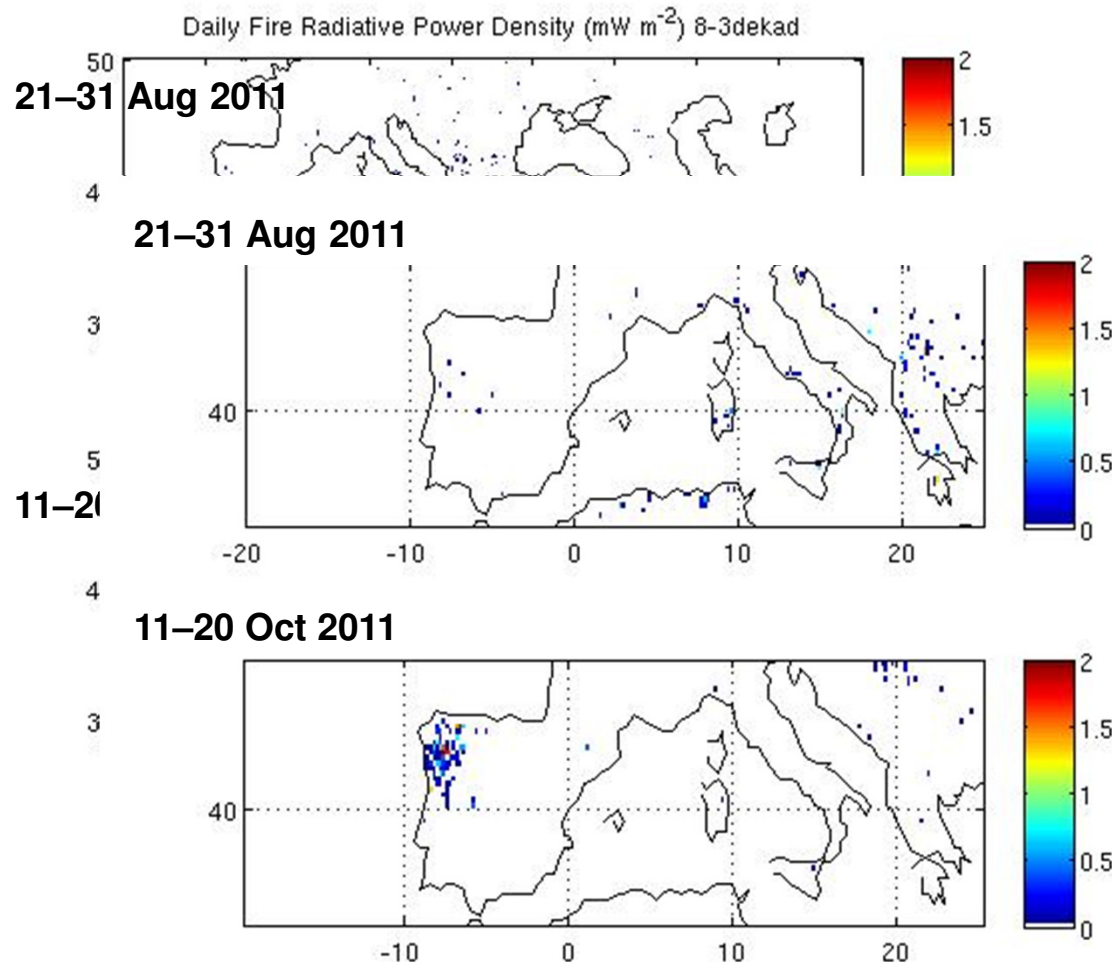
## Horn of Africa – Drought 2011



[www.eumetsat.int](http://www.eumetsat.int)

## Daily Fire Radiative Power estimated from SEVIRI/Meteosat

(LSA SAF)



Fire Radiative Power



Fuel Consumption Rate



Emissions Rate  
(gases, aerosols)

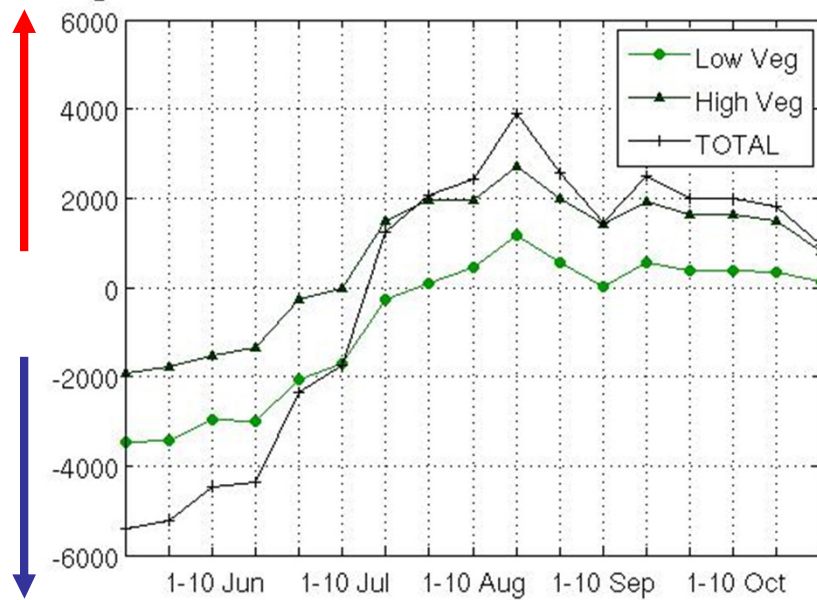
Biomass Rate ( $\text{kg/s}$ ) =  
 $0.368 (\pm 0.015) \times \text{Fire Rad Power (MW)}$

# Emissions from Wild Fires : Iberian Peninsula

(CO<sub>2</sub>  
Source)

May – October 2011

CO<sub>2</sub> Net Ecosystem Exchange (10<sup>9</sup>g/day) Iberian Peninsula

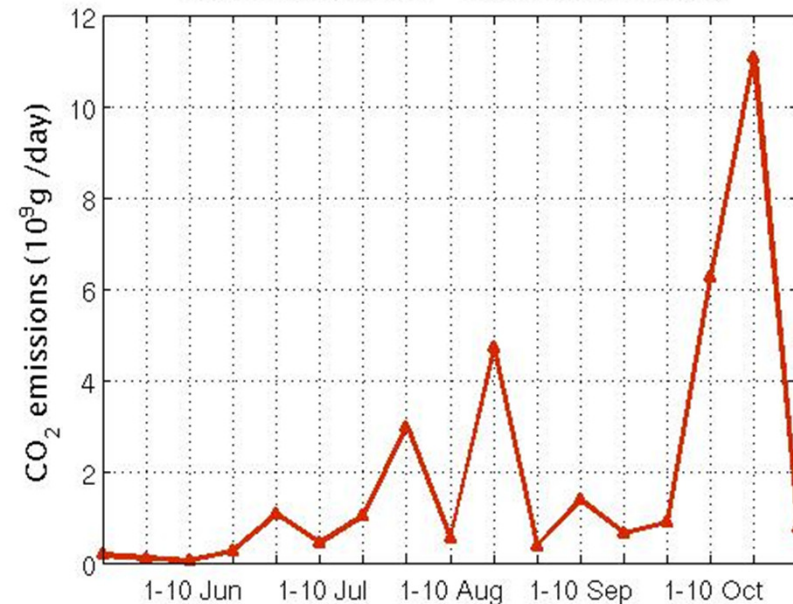


(Atmospheric CO<sub>2</sub>  
Sink)

## Fire Emssions

**May-Oct total: 331 x 10<sup>9</sup>g CO<sub>2</sub>**

Wild Fires Carbon – Iberian Peninsula

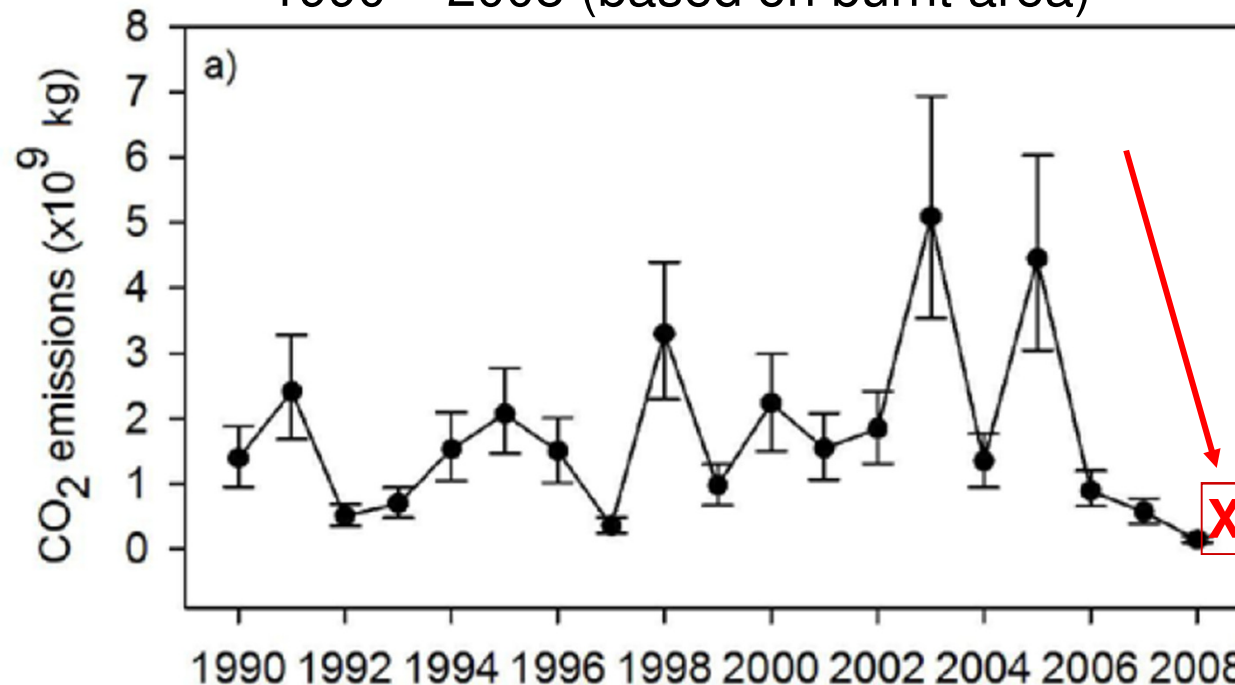




# Emissions from Wild Fires : Iberian Peninsula

## Annual CO<sub>2</sub> Fire emissions & uncertainty

1990 – 2008 (based on burnt area)

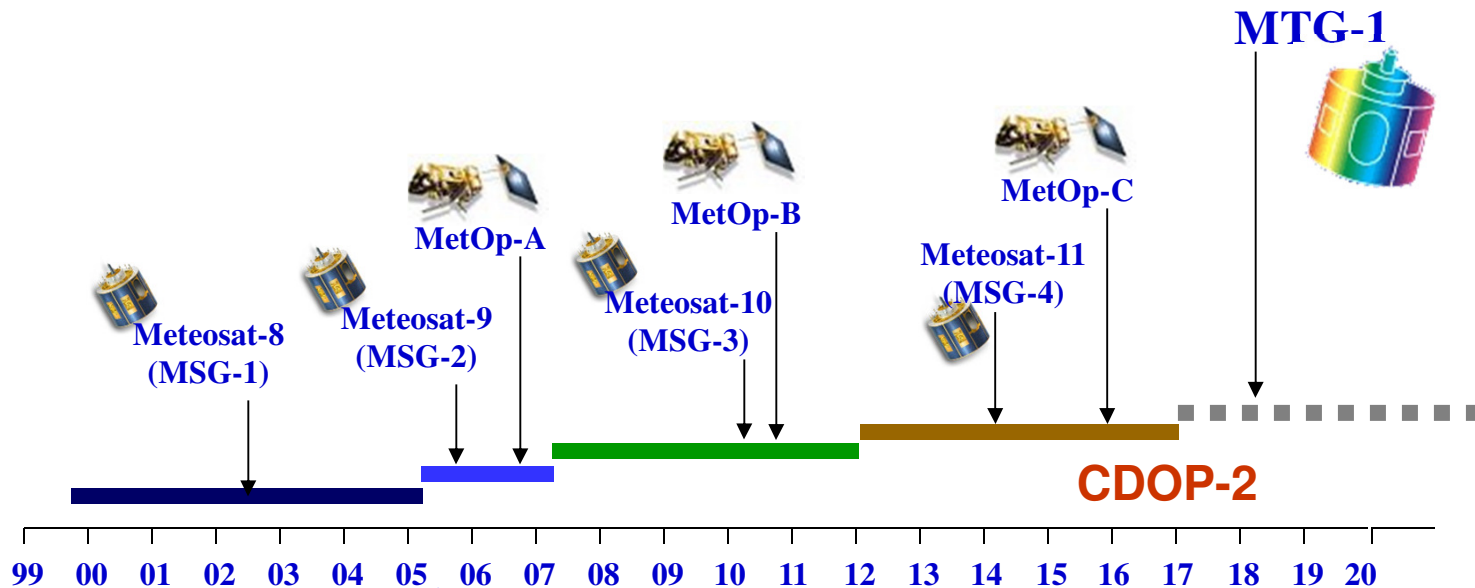


**CO<sub>2</sub> Fire emissions**  
in Iberia May – Oct  
2011: **0.33 x 10<sup>9</sup> kg**

at the level of years  
with the lowest fire  
activity.

Source: Rosa, Pereira and Tarantola, 2011 Atmos. Chem. Phys,  
Doi: 10.5194/acp-11-2625-2011

# LSA SAF Chronogram



**Development  
Phase:  
Sep 99 – Jan 05**

**Initial  
Operations  
Phase:  
Feb 05 – Feb 07**

**Continuous  
Development &  
Operations Phase - 2:  
Mar 12 – Feb 17**

## Improvement & Evolution of Products

- LST:**
- Improving sfc emissivity
  - Directional effects on LST
  - Climate Dataset (Meteosat 1st generation) – with CM SAF
  - All-Weather product
- Albedo:**
- AVHRR/Metop
  - Snow-free Albedo
- Surface Radiation Fluxes:**
- Diffuse and Total SW radiation
  - Net (SW and LW) products
- Evapotranspiration:**
- Latent & Sensible Heat Fluxes
- Vegetation:**
- Net and Gross Primary Productions
- Wild Fires:**
- Convergence of Fire detection for FD&M and FRP products
  - Fire emissions
  - Burnt Area & Vegetation Recovery

## Meteosat Third Generation

*Payload* will be distributed by 2 satellites

**Evolution of SEVIRI  
– based LSA SAF  
Products**

**MTG-I** (launch foreseen for 2018 - TBC)

**Flexible Combined Imager (FCI)**

16 channels (1km / 2 km; high-resolution 0.5 km)

10 min

**Lightning Imager (LI)**

Lightning detection (total - cloud-cloud & cloud-ground)

**MTG-S** (launch foreseen for 2020 - TBC)

**Infrared Sounder (IRS)**

800 channels LWIR+ 920 channels MWIR – full disk; 4 km

60 min

**Ultraviolet, Visible and Near-Infrared Sounding (Sentinel-4)**

UV: 305 – 400 nm; VIS: 400 – 500 nm; NIR: 755 – 775 nm

Europe; 60 min

<http://landsaf.meteo.pt>