Land Applications from LEO

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LEO SATELLITES

- **Polar orbits**
  - Altitude ~700-900 Km
  - Global coverage
  - Two observations/day
    - **Sun synchronous**
      - Pass over a given location at the same solar time on each orbit, allowing to view the scene always with the same sun illumination conditions

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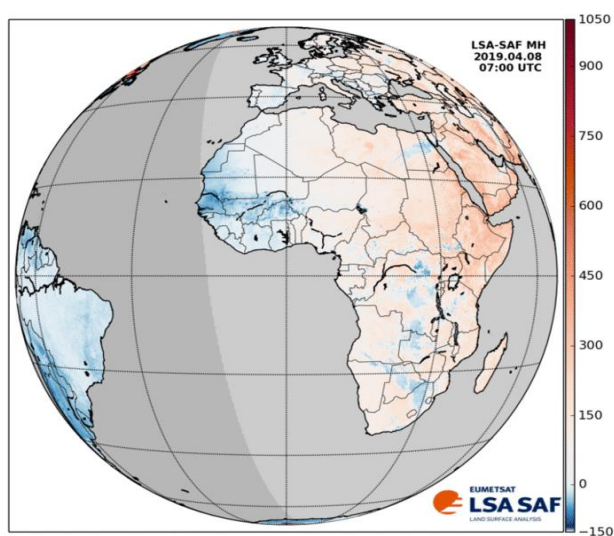   - **Land Applications**
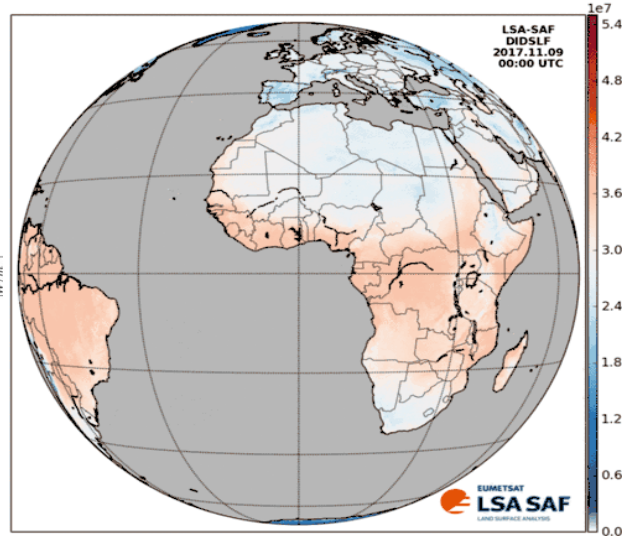
LAND SURFACE ANALYSIS SAF (LSA SAF)

EUMETSAT LSA SAF LAND SURFACE ANALYSIS

LSA SAF is a consortium of 10 members with Portuguese Institute for the Sea and Atmosphere (IPMA) as the leading entity.

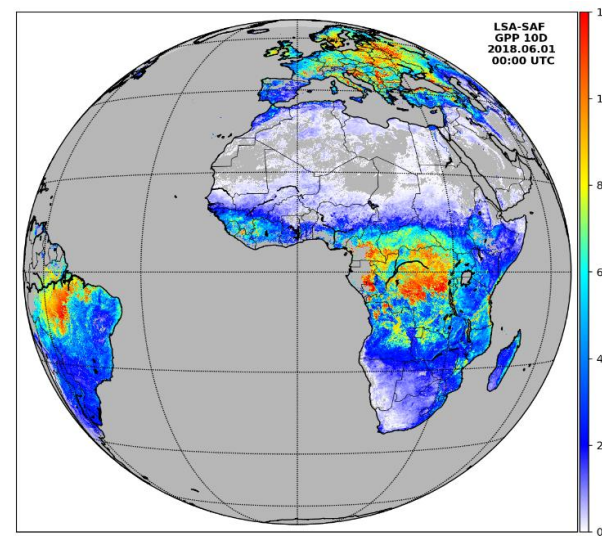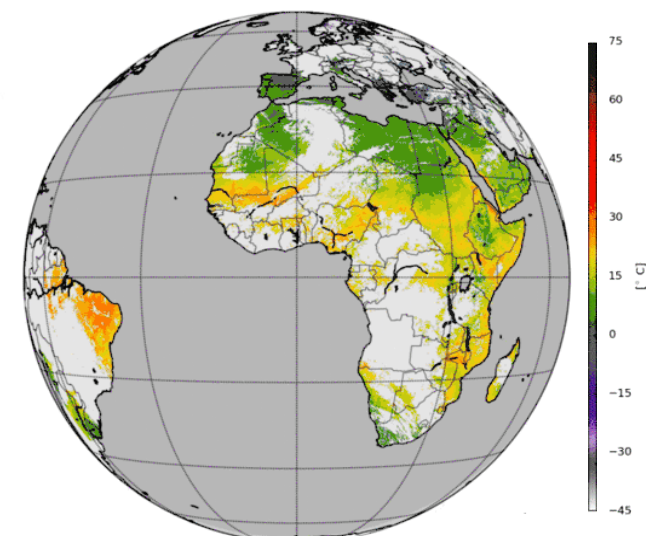IPMA · METEO FRANCE · KMI · KIT · vito · KING'S College LONDON · ARSO METEO

Sensible (MH) & Latent (MLE) Heat Fluxes, 2019

Daily Downward Surface Longwave Flux, 2017

MSG 10-days Gross Primary Production, 2018

Land Surface Temperature (LST) is the radiative skin temperature over land. LST plays an important role in the physics of land surface as it is involved in the processes of energy and water exchange with the atmosphere.

LSA SAF products provide information about:

- Land Surface temperature (GEO and **LEO**)
- Wild fires
- Albedo

- Evapotranspiration and energy FLXs
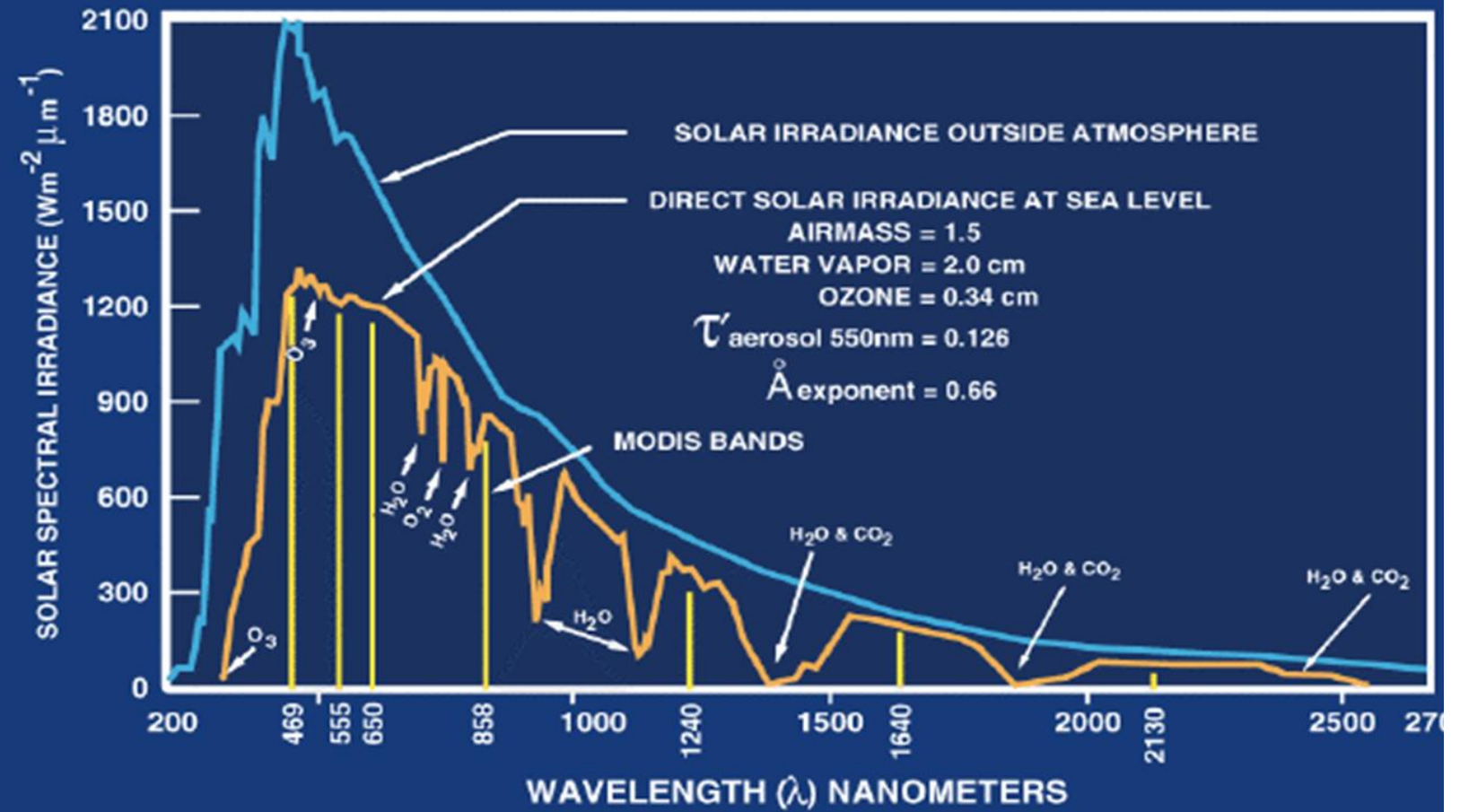- Longwave and shortwave radiation
- Vegetation (GEO and **LEO**)

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WHAT DO SATELLITES MEASURE?

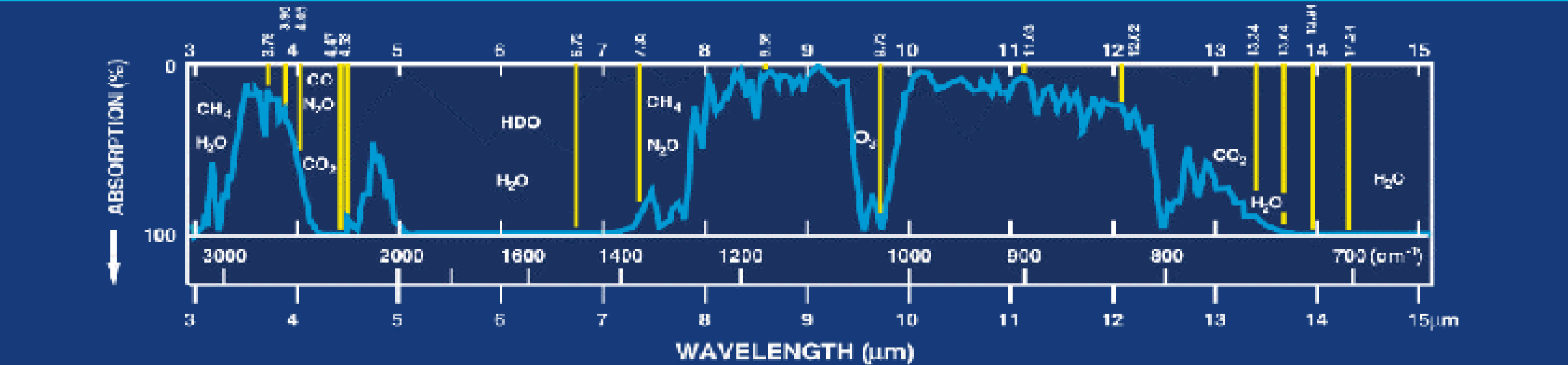**Solar radiation**: reflected by the surface, scattered by molecules, cloud droplets, ice crystals, aerosols

Thermal radiation: emitted by the Earth / clouds / atmosphere

www.data.jma.go.jp
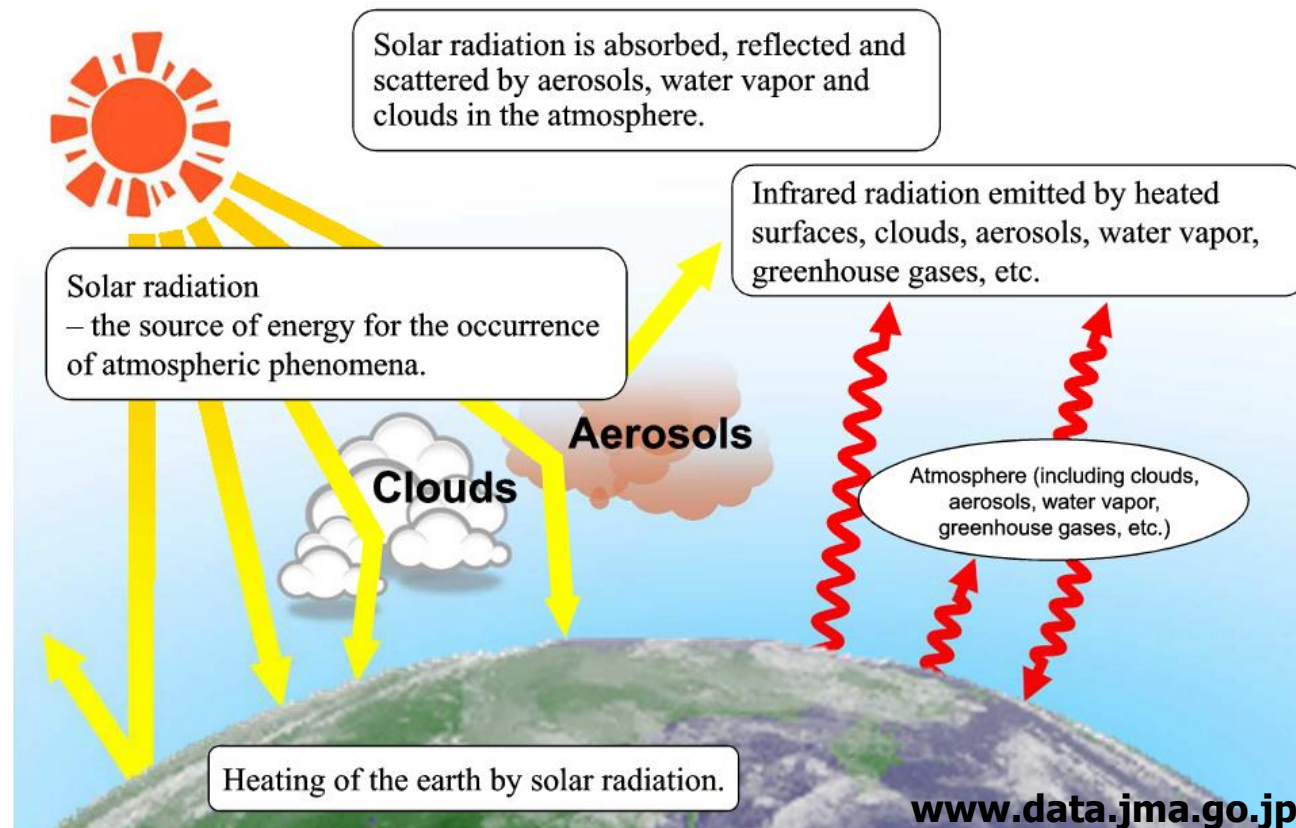
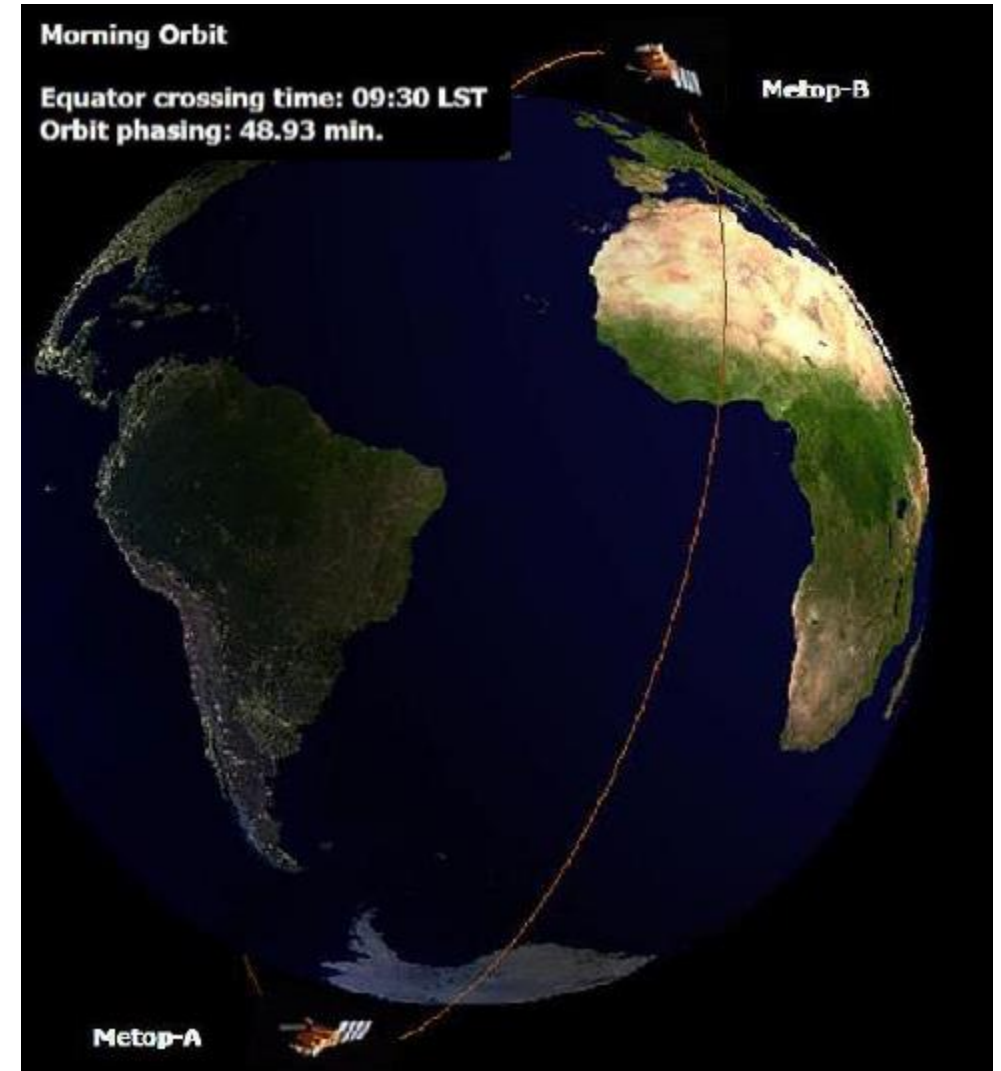# SOLAR RADIATION

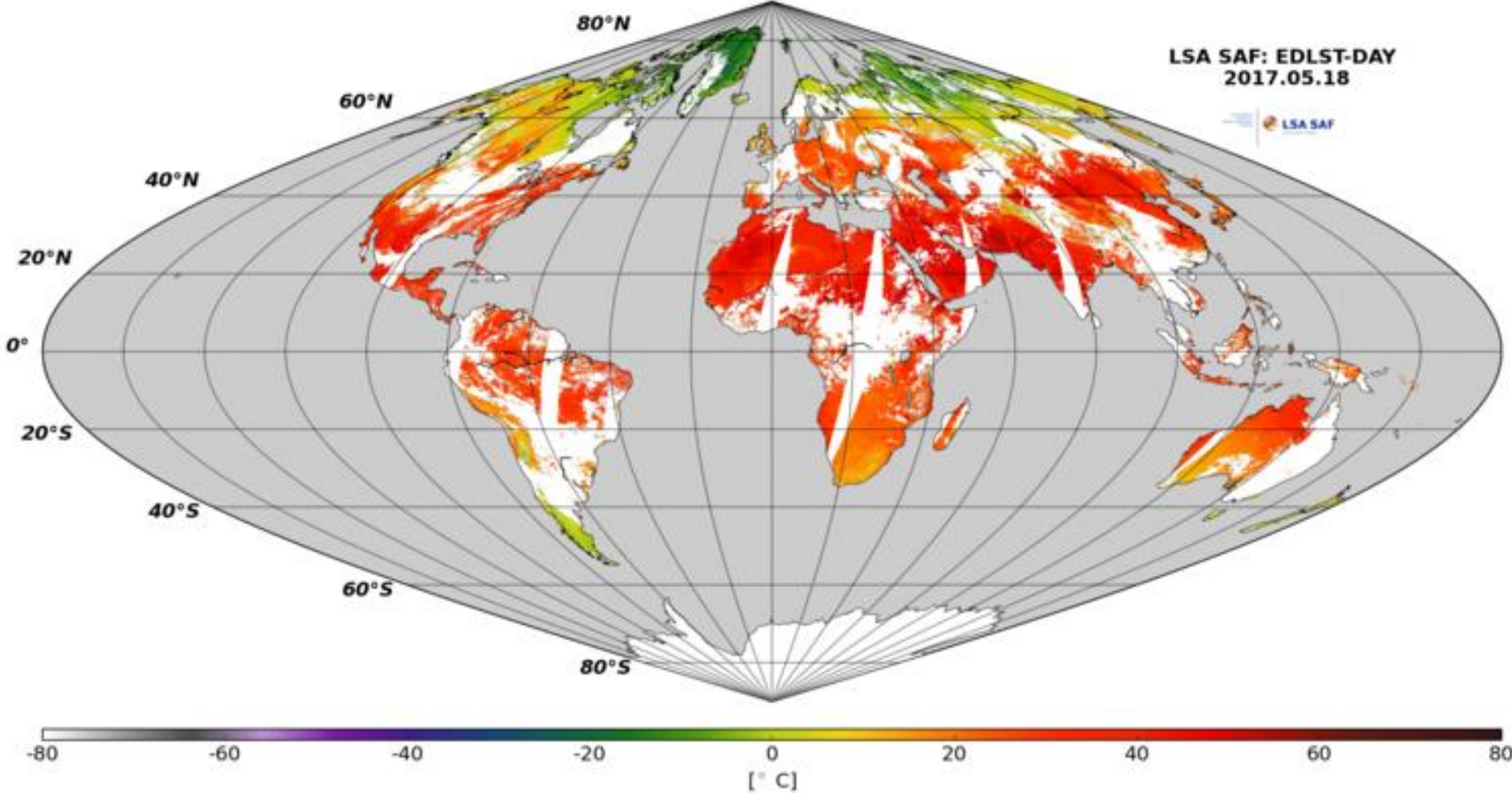# THERMAL RADIATION

LEO SATELLITES

Metop

(EUM Polar Orbiter
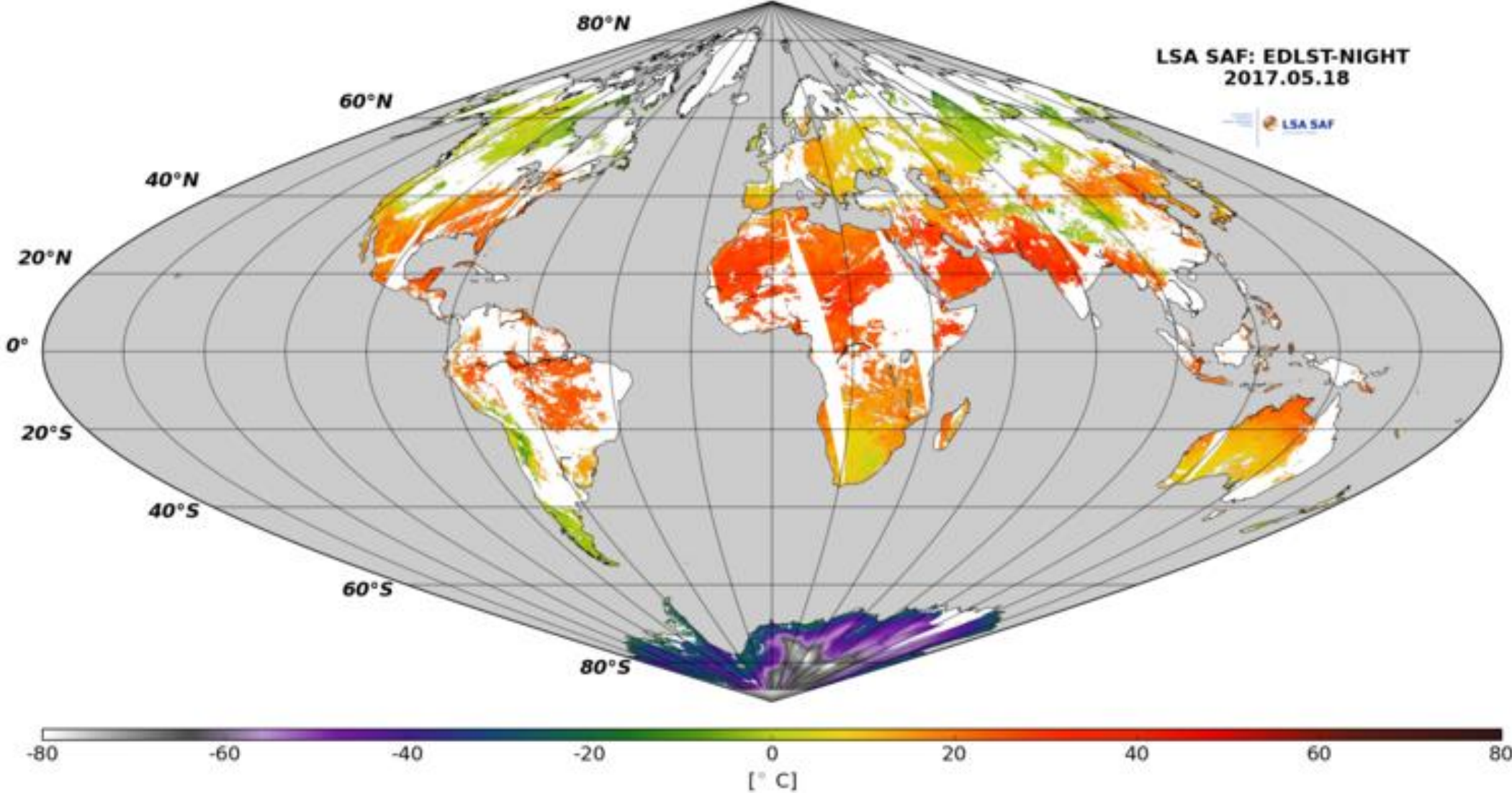Advanced Very High
Resolution Radiometer (AVHRR))

- 5 channels at the center wavelengths of 0.630,
  0.865, 1.61, 3.74, 10.8, and 12.0 µm

- 2 observations/day, GLOBAL

- ~1 km at sub satellite point

Morning Orbit

Equator crossing time: 09:30 LST
Orbit phasing: 48.93 min.

Metop-B

Metop-A

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LAND SURFACE TEMPERATURE

LAND SURFACE TEMPERATURE

LSA SAF: EDLST-NIGHT
2017.05.18

LAND SURFACE TEMPERATURE

EDLST (LSA-002)

- Period: **2015** – onwards (continuously updated in NRT);
        Back-processing from 2007 onwards to be released soon.

- Area Coverage: global

- Temporal sampling**: twice daily** (daytime and night-time LST)

- Spatial Resolution and format – 2 versions of the dataset available:

        - sinusoidal grid at 1km resolution in HDF5 format

        - projected on regular 0.01º x 0.01º grid; NetCDF4

LAND SURFACE TEMPERATURE – WHAT CAN WE DO WITH IT?
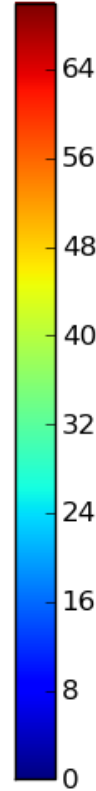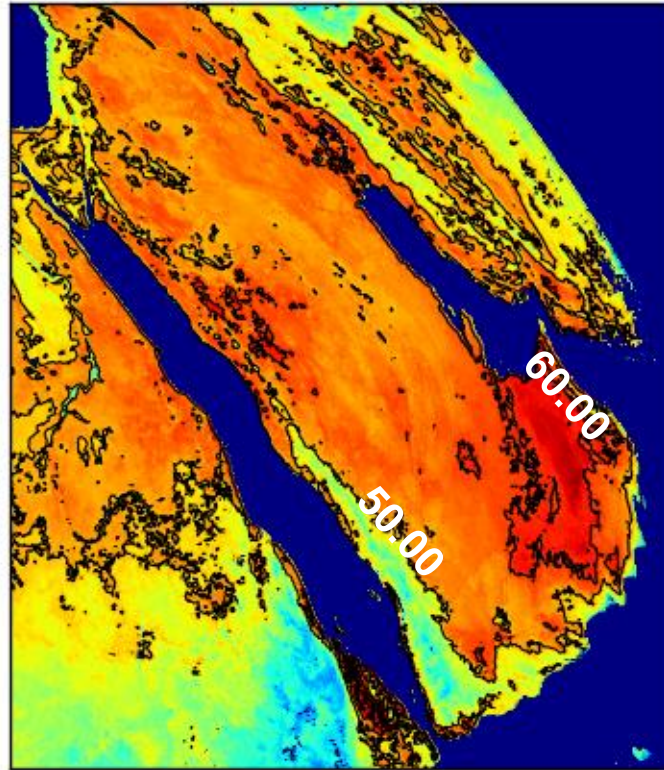
Applications:

- Climate Monitoring

- Extreme heat/cold spells

- Crop water requirements assessment

- Determine crops frost damage

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LAND SURFACE TEMPERATURE – WHAT CAN WE DO WITH IT?
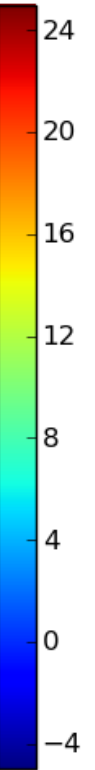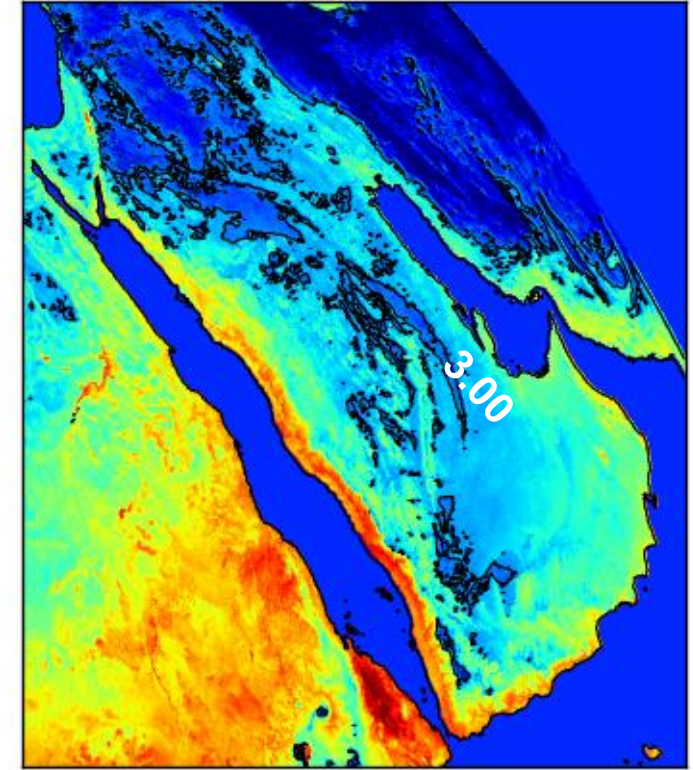
Applications:

- Climate Monitoring

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201008 @ 0900UTC

201001 @ 0300UTC

LAND SURFACE TEMPERATURE – HOW IS IT OBTAINED

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 μm).

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LAND SURFACE TEMPERATURE – HOW IS IT OBTAINED

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How is it obtained?

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

    - $LST = f (Tb_{10.8}, Tb_{12.0}, \varepsilon_{10.8}, \varepsilon_{12.0}, \dots)$

Computed from spectral reflectance libraries

$\varepsilon_\lambda B_\lambda (LST)$

The effect of the atmosphere needs to be corrected (absorption by water vapor and other atmospheric gases)

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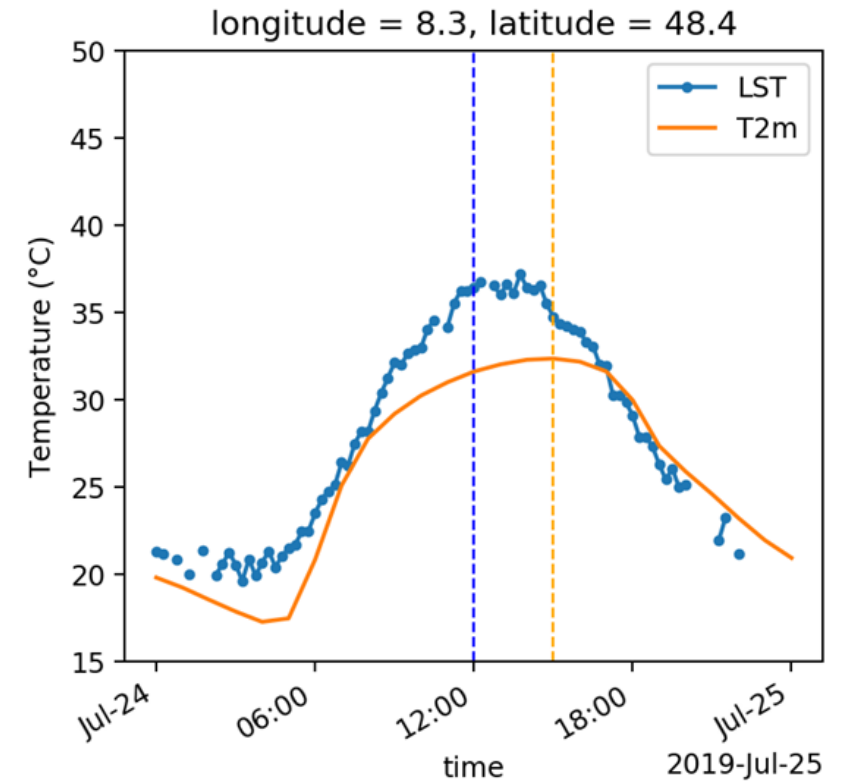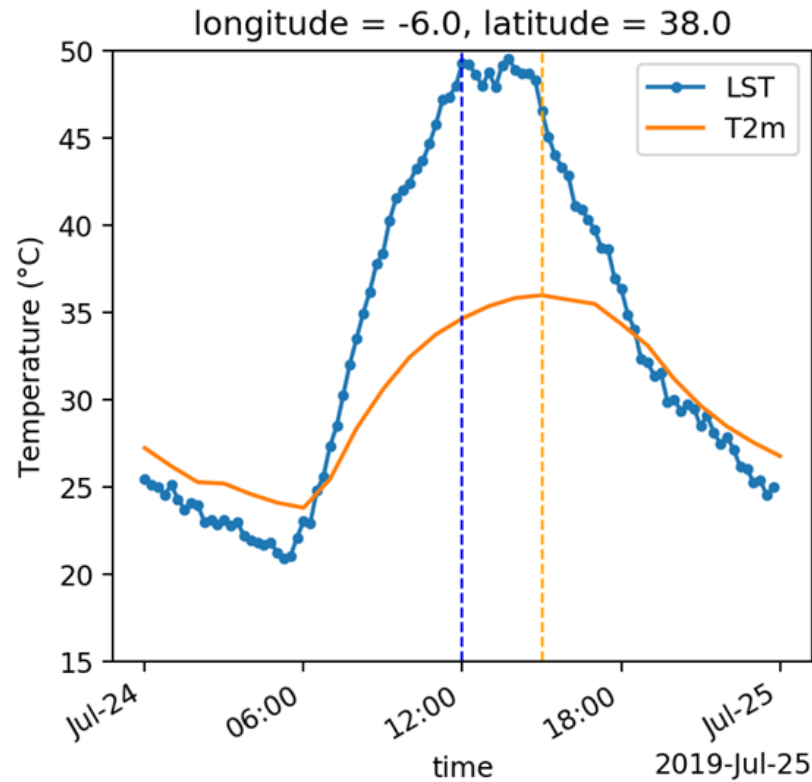# LAND SURFACE TEMPERATURE – HOW IS IT OBTAINED

Although strongly correlated, LST ≠ 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)

HOW TO ACCESS LSA-SAF DATA

http://lsa-saf.eumetsat.int

MODIS LST

- https://worldview.earthdata.nasa.gov/

- LST is available from Terra and Aqua satellites

  since 2002

  - 1 Km spatial resolution

  - Temporal resolution: daily, 8 days, monthly
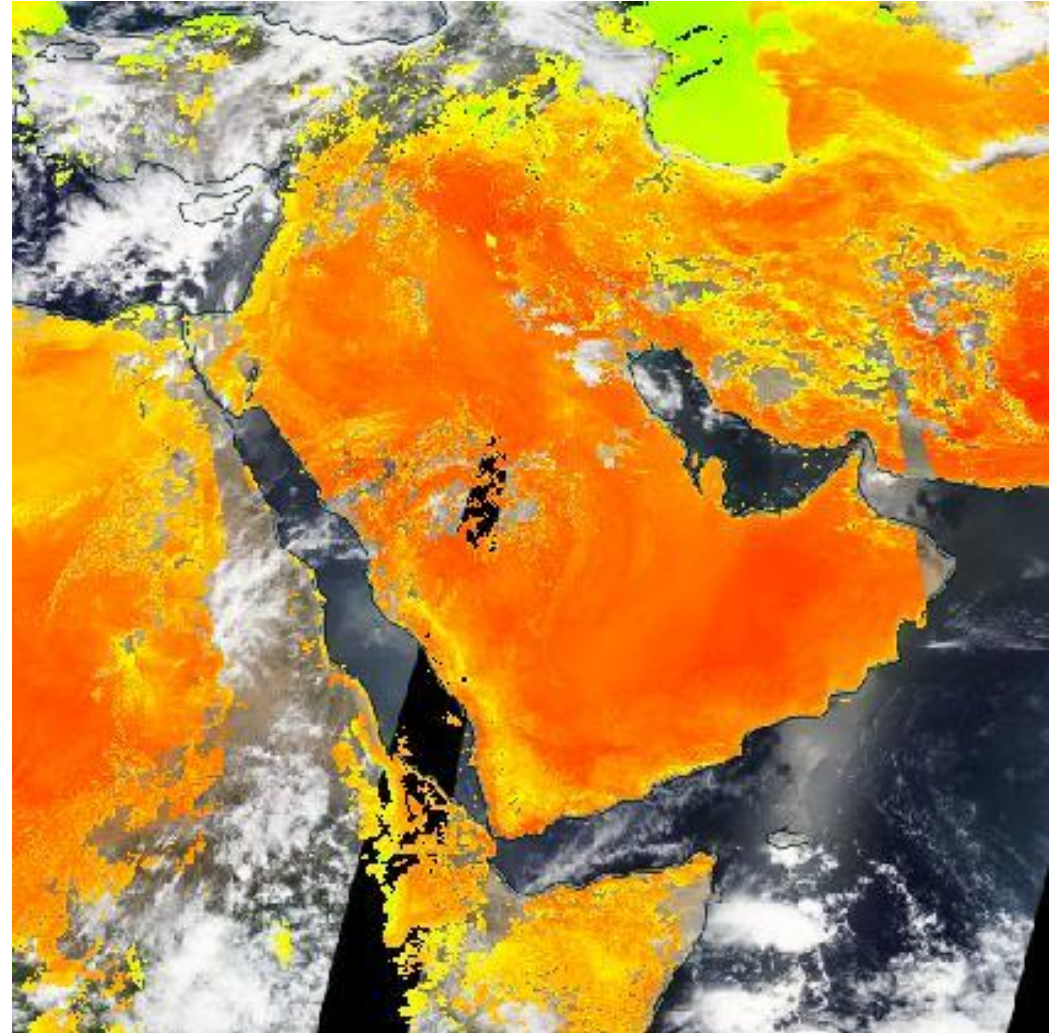
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NDVI

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

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

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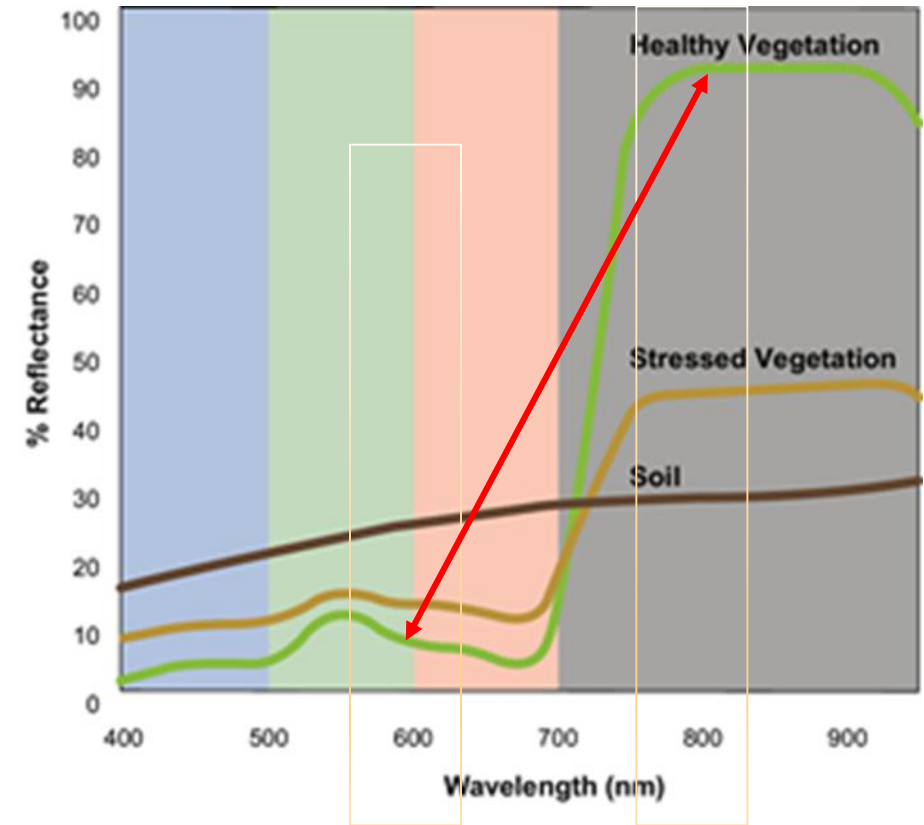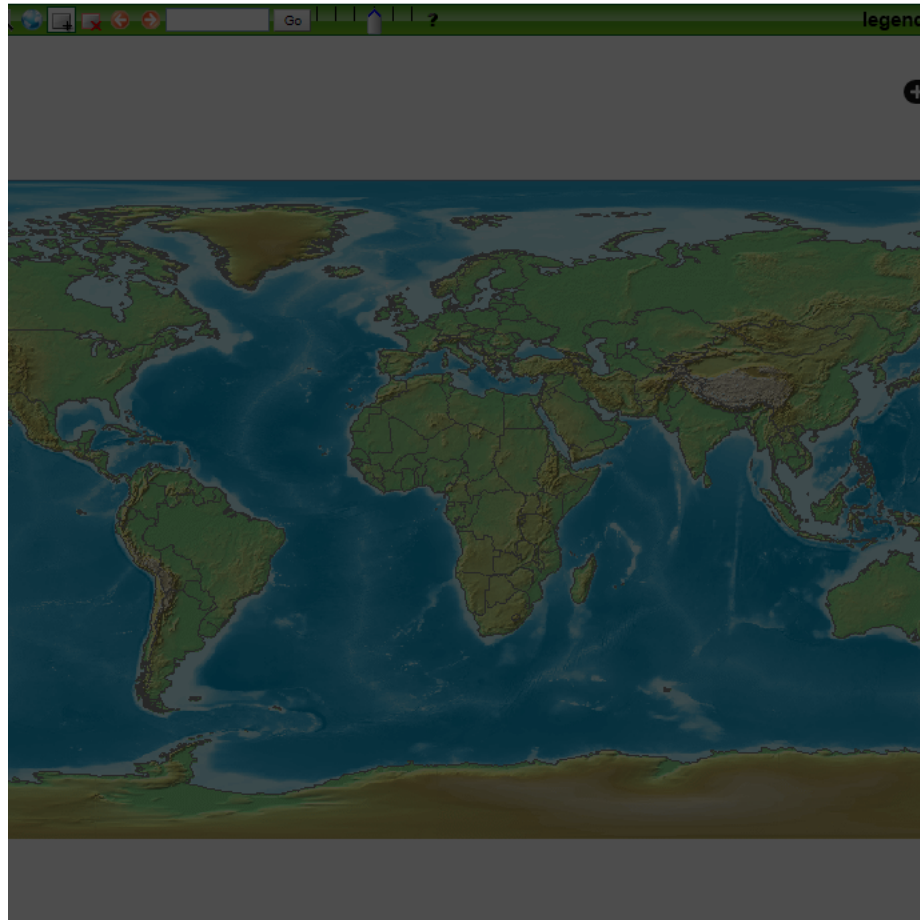
NDVI
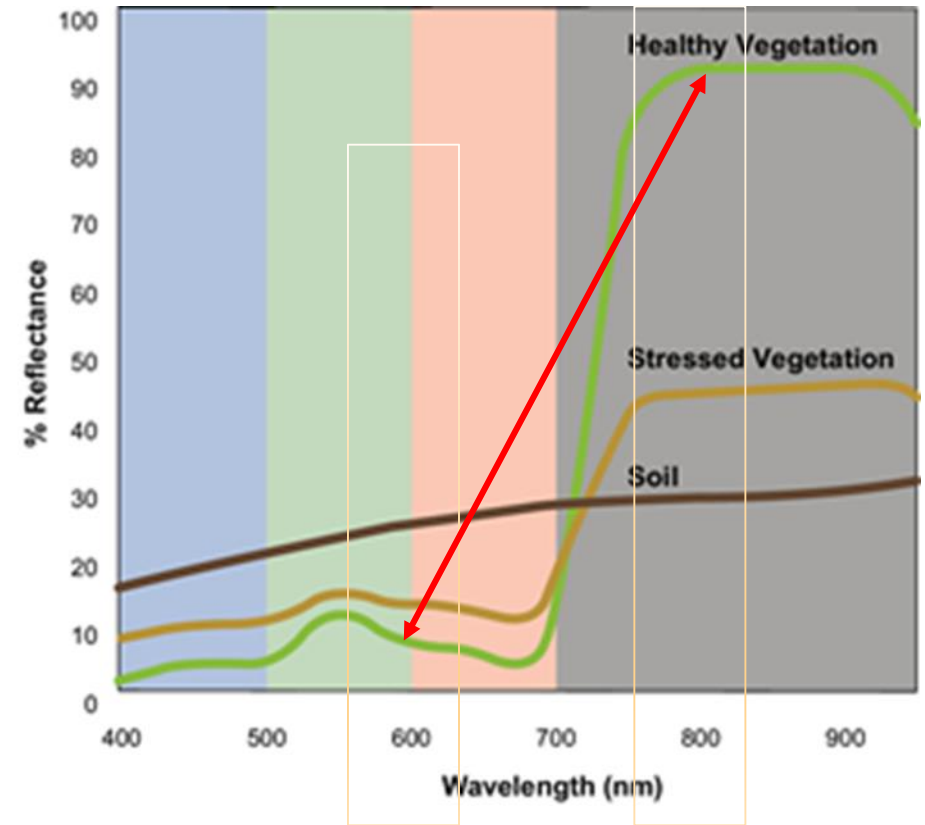
Algorithm

Top Of Atmosphere (TOA) radiances (**AVHRR/Metop)** in the 0.6 and 0.8 µm channels are converted into surface reflectances (Top-of Canopy, TOC). For the atmospheric correction the algorithm 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

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NDVI – HOW TO DOWNLOAD

https://www.vito-eodata.be/PDF/portal/Application.html#Browse;Root=500439;Collection=85301700;Time=NORMAL,NORMAL,-1,,,-1,,

BIOGEOPHYSICAL PRODUCTS

Fraction of Photosynthetically Active Radiation (fAPAR)

- fraction of radiation in the PAR region (0.4 µm - 0.7 µm) 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
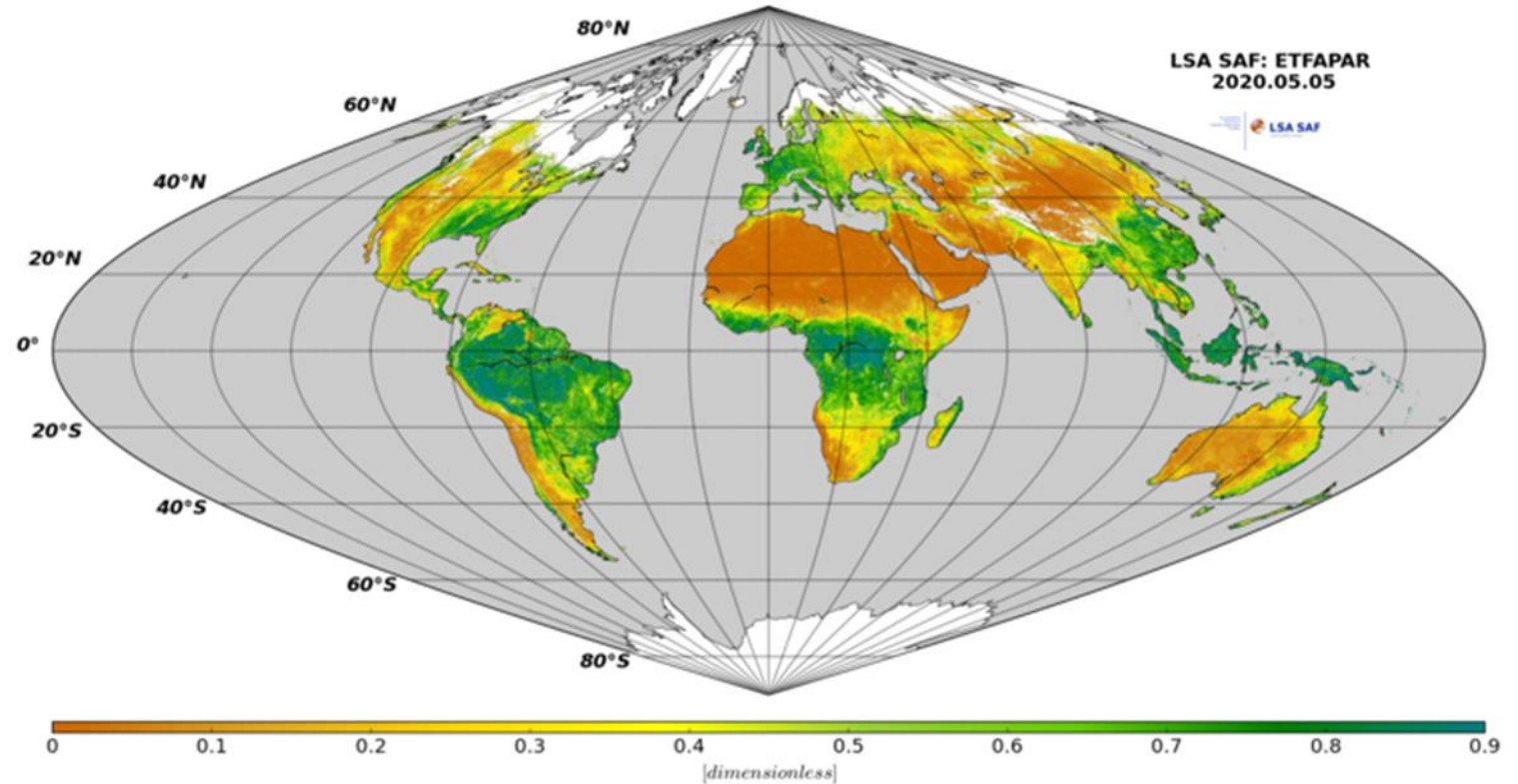
Frequency & temporal coverage

- Monthly, updated every 10 days

- since 2015

BIOGEOPHYSICAL PRODUCTS

Fraction of Vegetation Cover (FVC)

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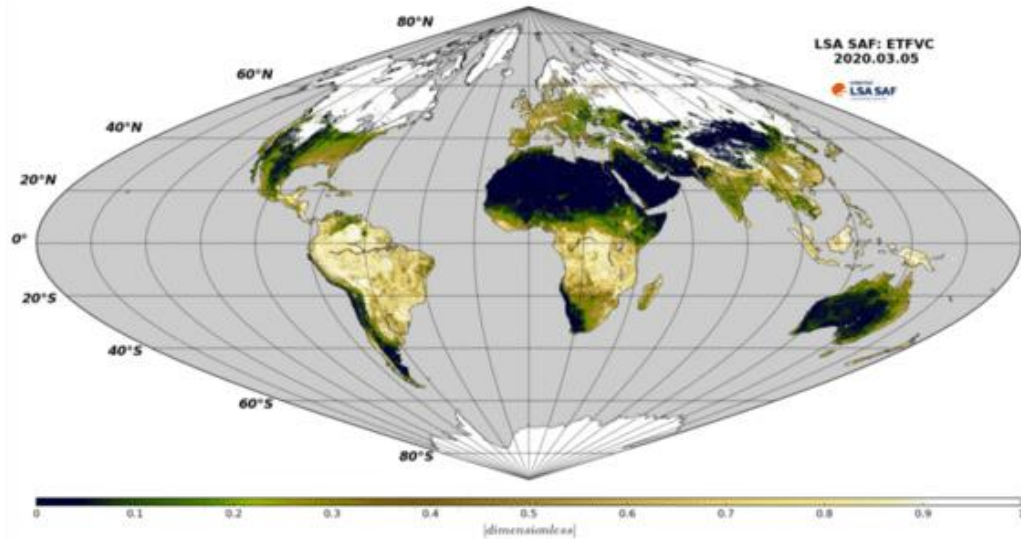

Leaf Area Index (LAI):

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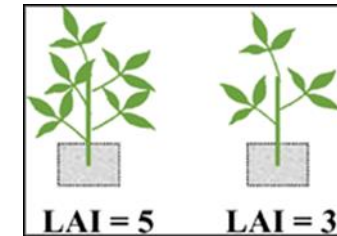
FVC & LAI define important structural properties of a plant canopy

Frequency & temporal coverage

- Monthly, updated every 10 days

- since 2015

BIOGEOPHYSICAL PRODUCTS

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.
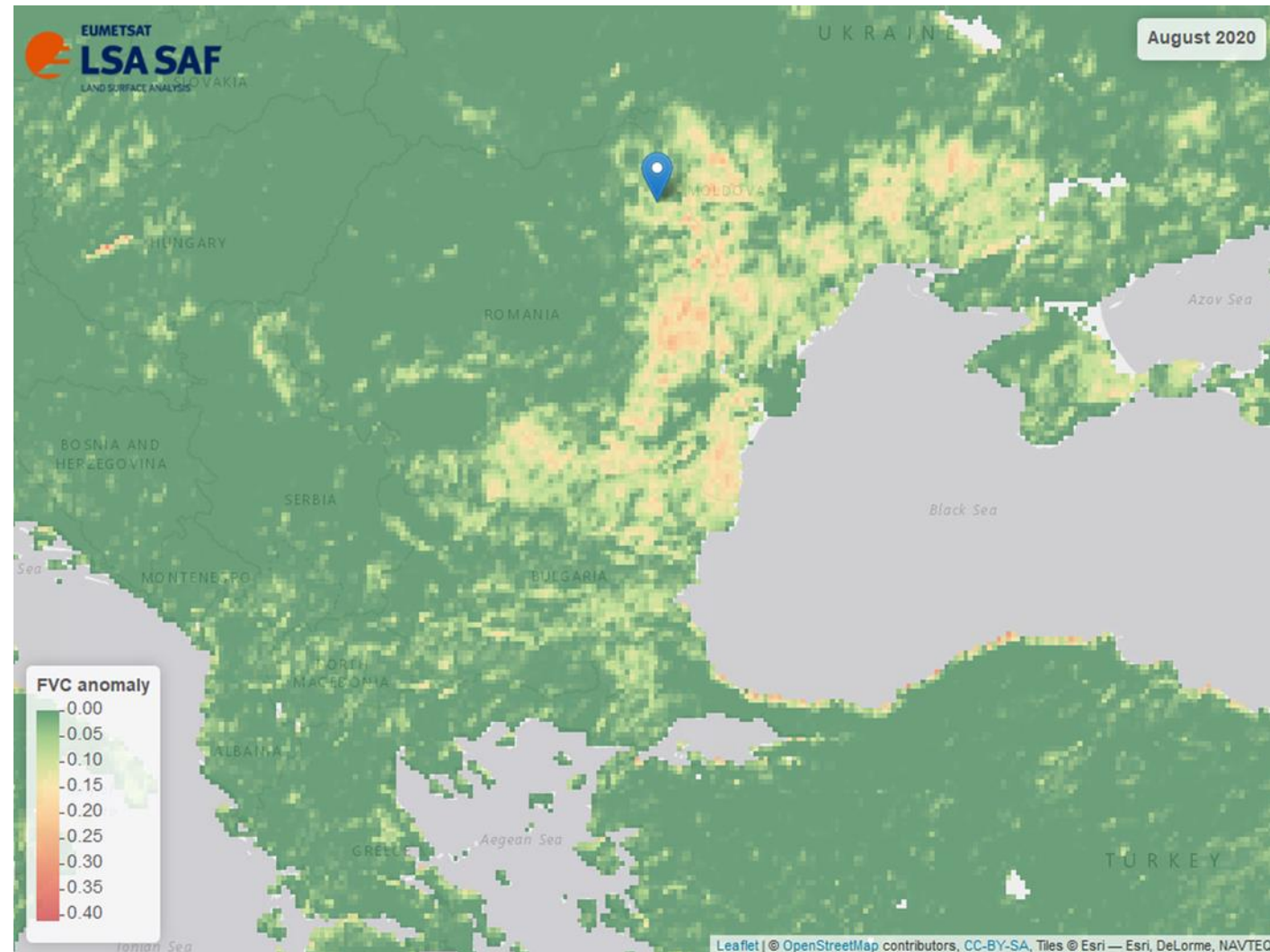
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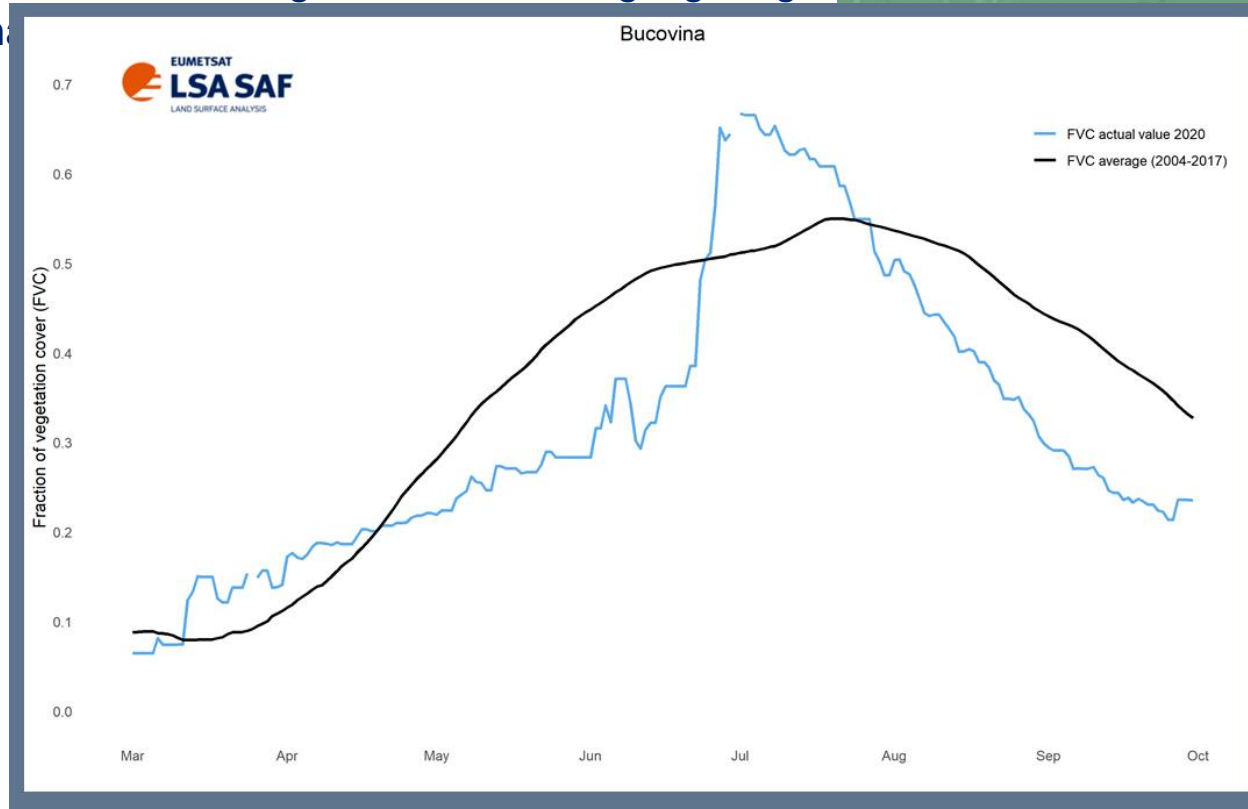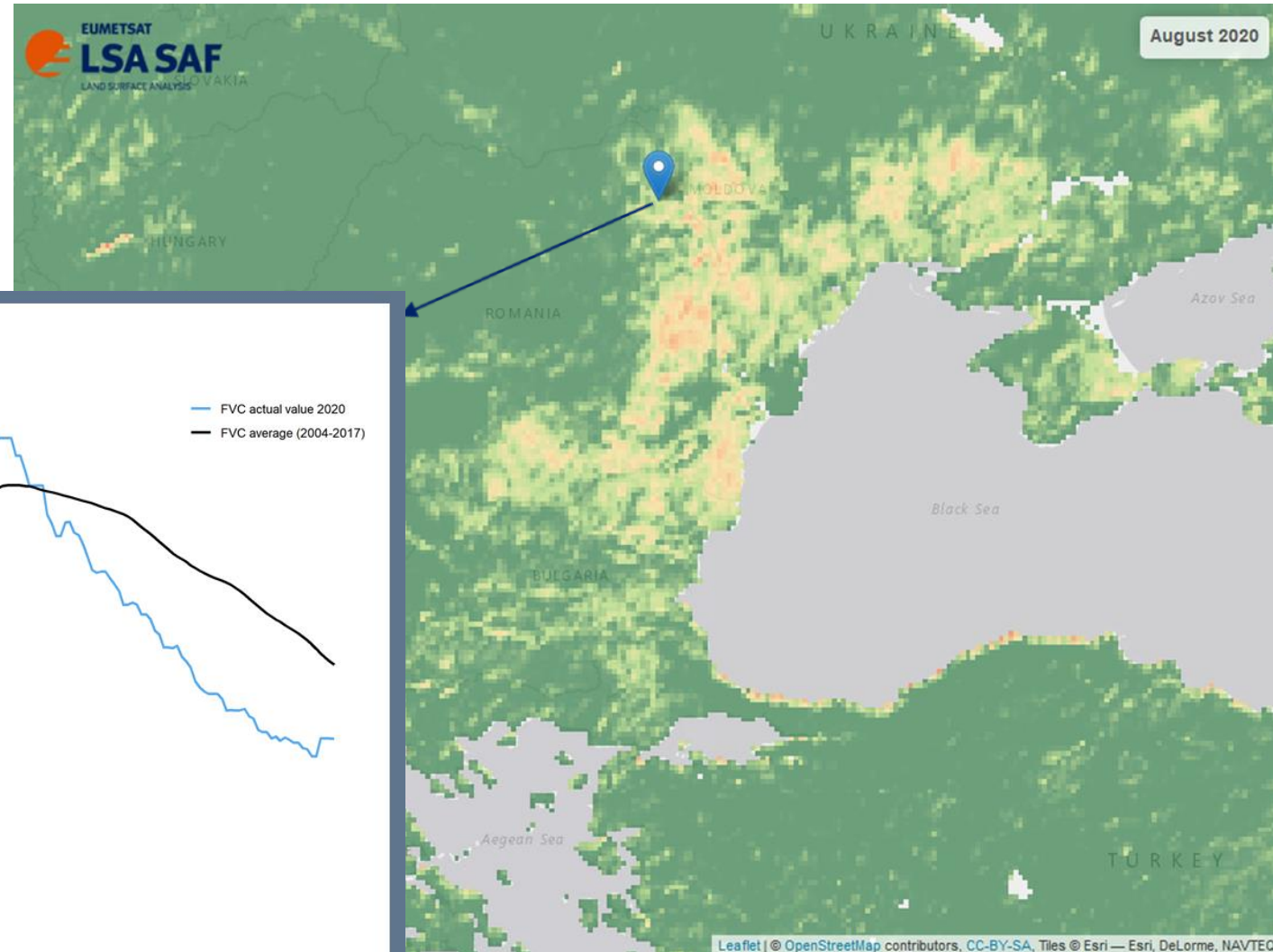
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FIRE DETECTION

FRP ∝ **Combustion rate**

∝ **Smoke release**

LSA-SAF FRP
01-2014

FRP ∝ **Combustion rate**

∝ **Smoke release**

Underestimation of FRP-SEVIRI often occurs due to:

- Undetected weak/small fires;

- Saturation of the MIR channel in extreme intense fires

LSA-SAF FRP
01-2014
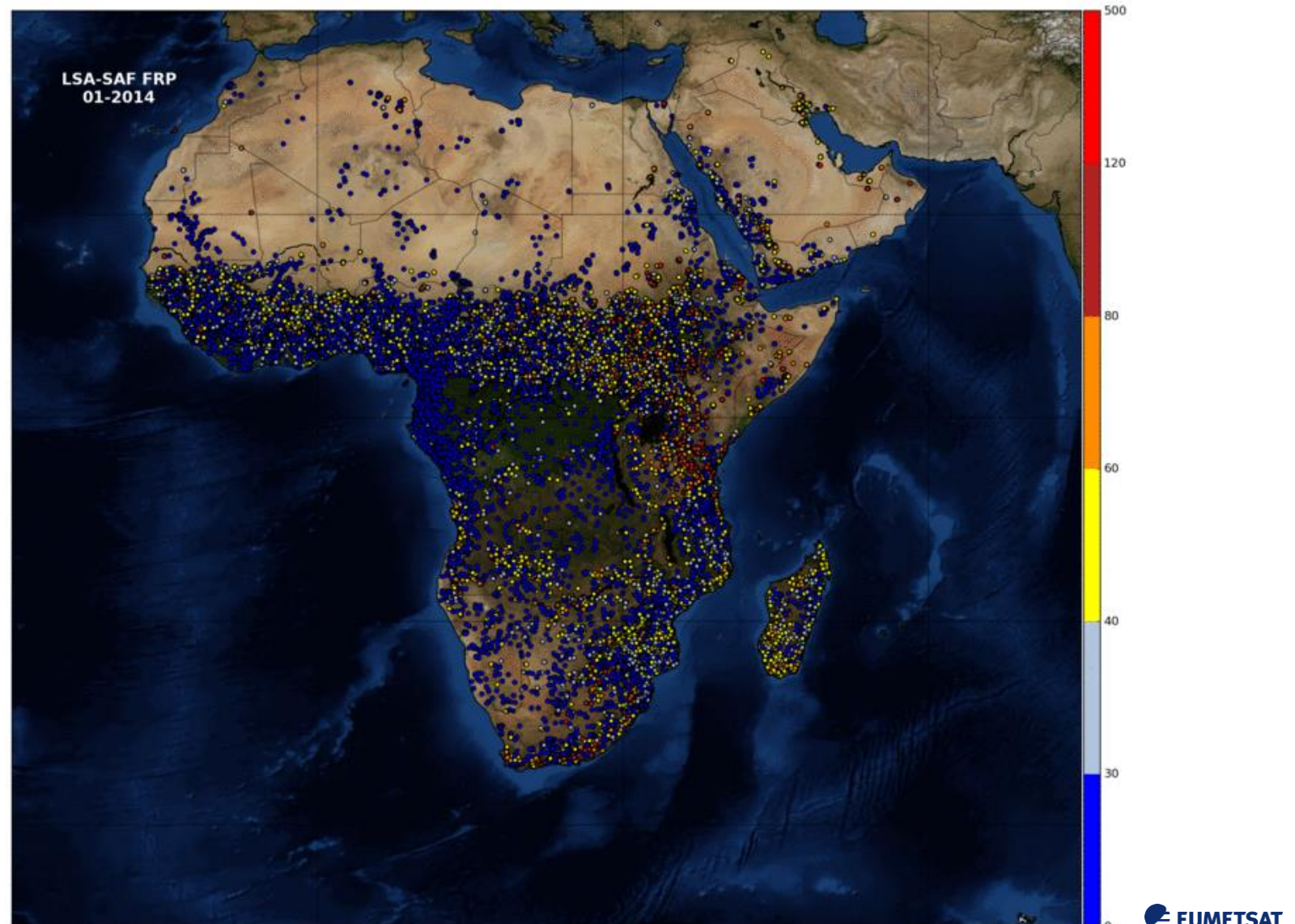
FIRE DETECTION

- Spatial Resolution

  - impossible to distinguish different flare sites within small areas (size of an MSG pixel in the Persian Gulf area ~ 5 x 6 Km);

MSG PIXEL   **MSG PIXEL**
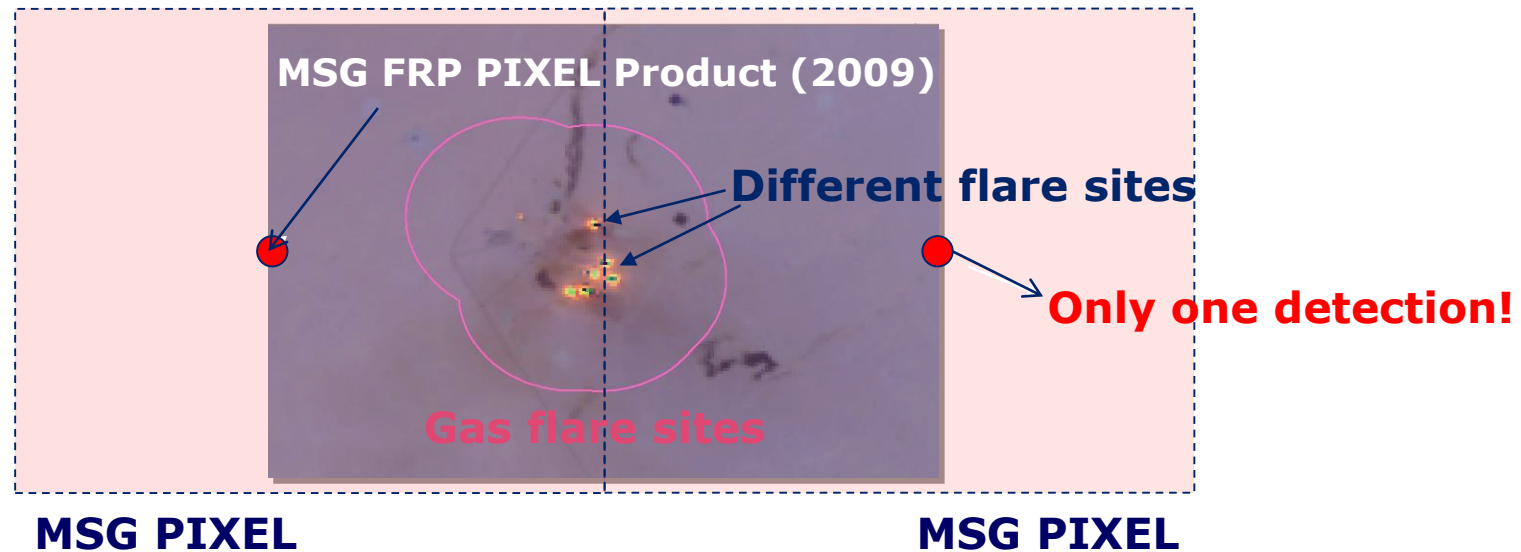
- Difficult to get exact location of flare sites – the temperature anomaly detected is given for the center of the pixel which doesn't always correspond to the position of the features.

FIRE DETECTION

Fire Map - NASA | LANCE | FIRMS

Fire and Thermal Anomalies from MODIS (1 Km) and VIIRS (375 m)

- shows active fire detections and thermal anomalies, such as volcanoes, and gas flares.
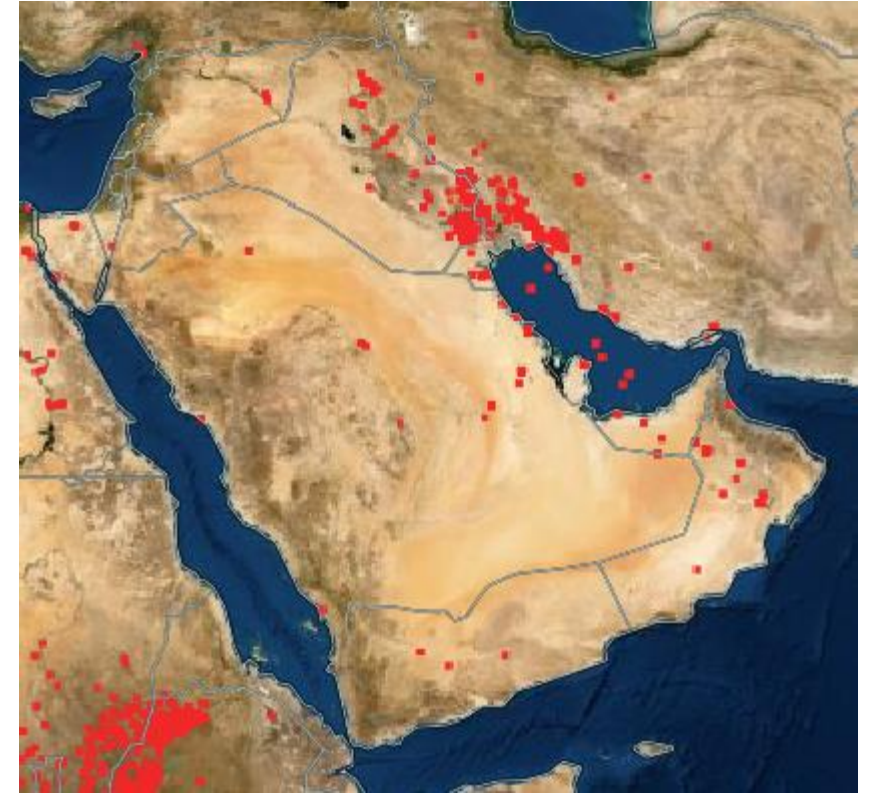
VIIRS is the successor to MODIS for Earth science data product generation.

VIIRS NRT 375 m active fire products are from Suomi NPP and NOAA-20 (formally known as JPSS-1)

- **MODIS/Terra Temporal Coverage: 1 November 2000 – present**
- **MODIS/Aqua Temporal Coverage: 3 July 2002 – present**
- **VIIRS S-NPP temporal coverage: 20 January 2012 – present**
- **VIIRS NOAA-20 temporal coverage: 1 January 2020 - present**

Fire Map - NASA | LANCE | FIRMS

https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms

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SOIL MOISTURE

**H SAF Root-zone Soil wetness index products**

Available as:

- NRT – RZSM-ASCAT-NRT-10km (H26)

- Climate Data Record Products

  - RZSM-DR2019-10km (H141) (Data record: 1992-2018)

  - RZSM-DR-EXT-10km (H142) (Offline extension: 2019-2021)

- horizontal resolution of about **10 km** on four vertical layers in the soil: surface to 7 cm, 7 cm to 28 cm, 28 cm to 100 cm, and 100 cm to 289 cm.

- **daily** products valid at 00UTC.

- expressed as liquid SWI, with units between 0 (residual soil moisture) and 1 (saturation)

- generated by assimilating ERS 1/2 (for the case of H141) and ASCAT (A/B) -derived surface soil moisture observations into the dedicated H SAF land data assimilation system.
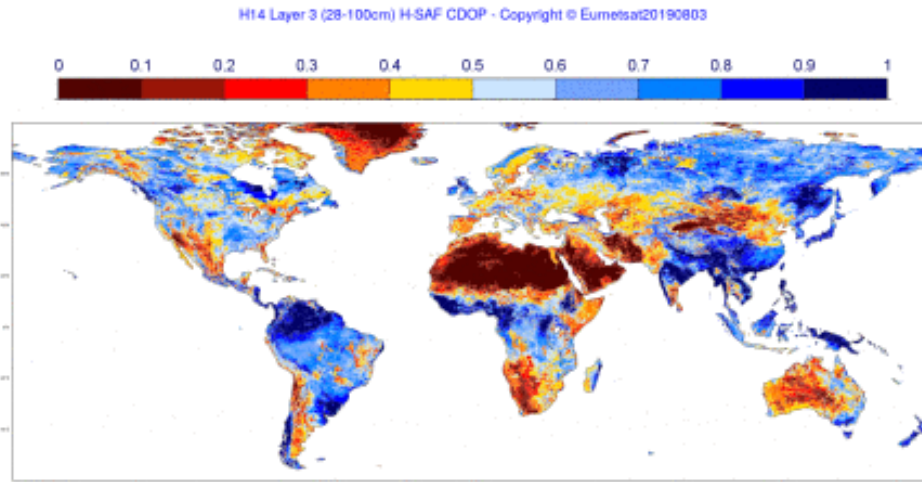
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# SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT SAF (H SAF)

H SAF is a consortium of 21 members from 11 countries with the Italian Air Force Meteorological Service (ITAF USAM) as the leading entity.
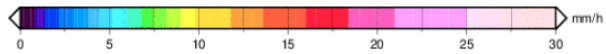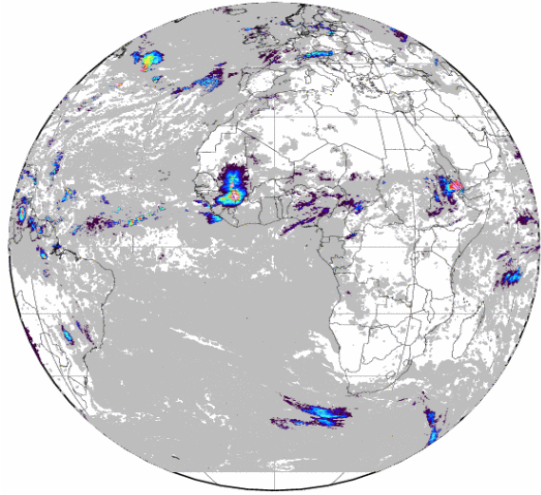
Instantaneous Rain Rate retrieved from IR-MW blending data , 2019

Profile Index in the roots region by scatterometer data assimilation H SAF, at different depths, July 2019
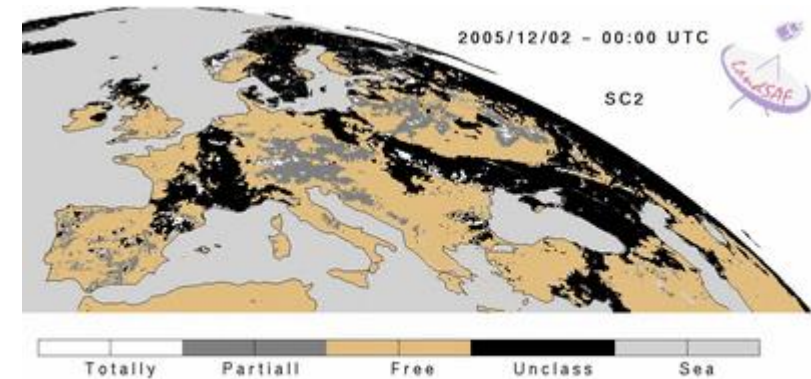
Snow detection for flat land (snow mask) by VIS/NIR of SEVIRI 2005

H SAF DATA AND PRODUCTS

The H SAF provides products on water at the ground in order to monitor hazards and natural disasters such as flash floods, landslides and drought conditions, as well as to improve water management.

Products are retrieved from the microwave and infrared instruments.

H SAF products cover three parameters:

- Precipitation (liquid, solid, rate, accumulated).

- Soil moisture (large-scale, at local-scale, at surface, in the roots region).

- Snow parameters (detection, cover, melting conditions, water equivalent).
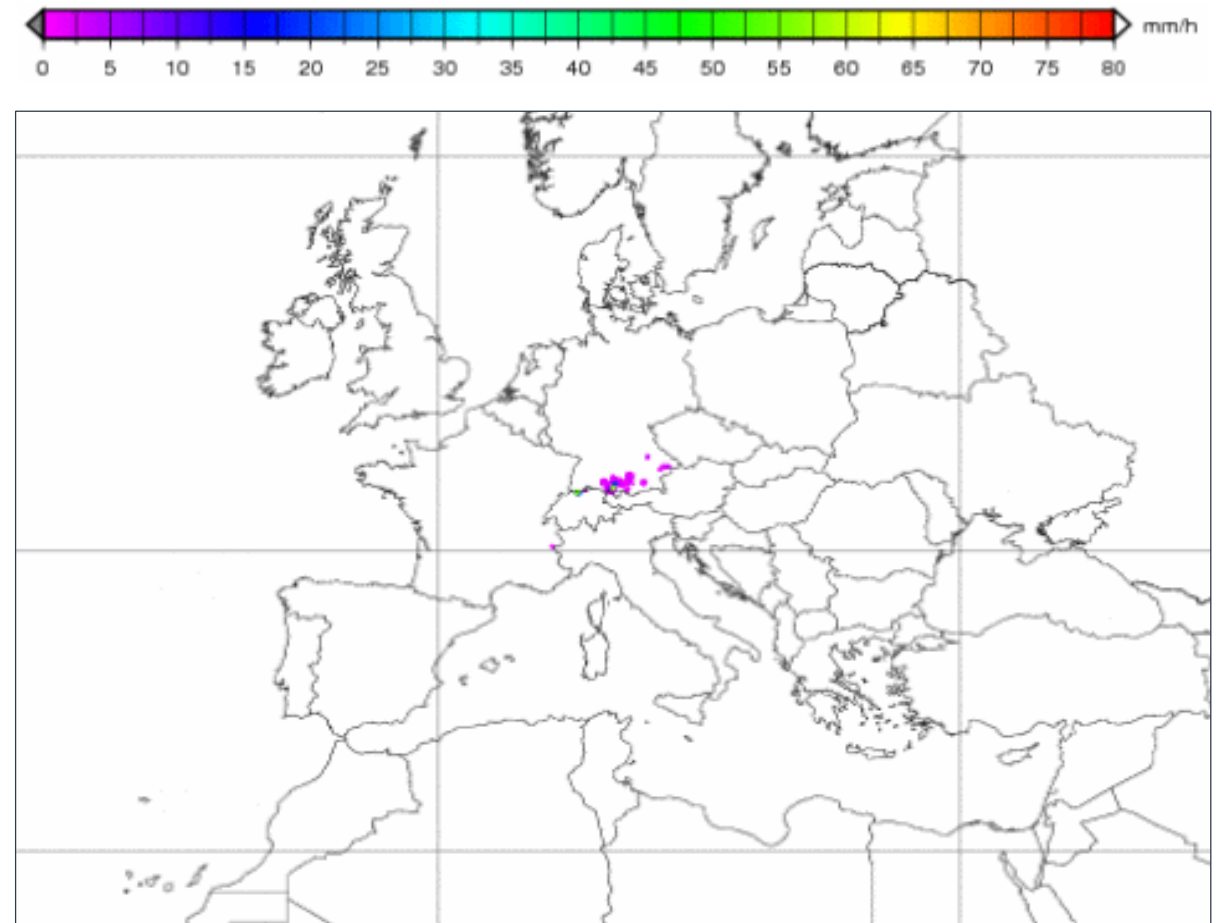
Blended SEVIRI Convection area / LEO MW Convective Precipitation July 2019.

SOIL MOISTURE –DATA ACCESS AND DISPLAY

[5th_hsaf_user_Workshop/hsaf_rzsm_demo.ipynb at main · H-SAF/5th_hsaf_user_Workshop · GitHub](#)

USEFUL LINKS

https://www.eumetsat.int
http://www.eumetrain.org/
https://training.eumetsat.int/
https://www.eumetsat.int/case-studies

THANK YOU!

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