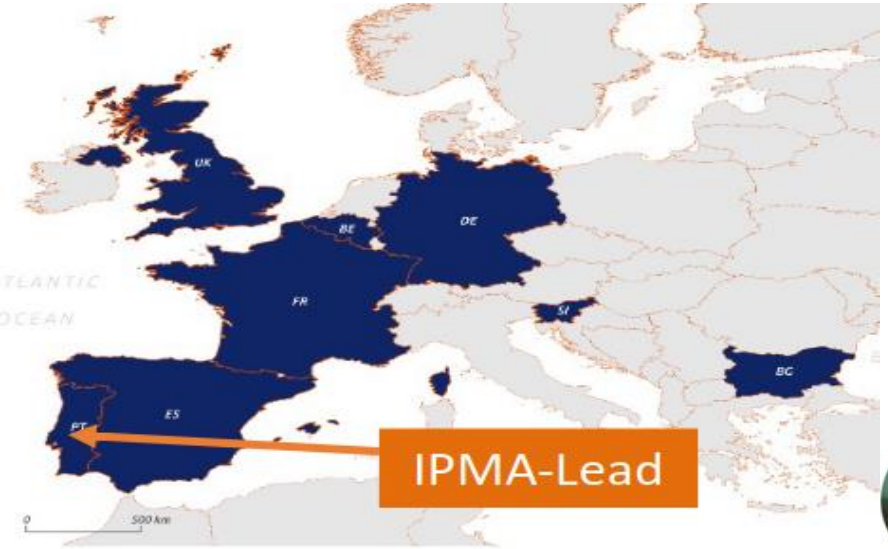
Case studies and applications based on products from Satellite Application Facility on Land Surface Analysis

Boštjan Muri, Mateja Iršič Žibert, Ahac Pazlar, Janko Merše

Slovenian Environment Agency



IPMA	(Portugal) – Leading Institution
MF	(France)
RMI	(Belgium)
IDL	(Univ Lisbon)
KCL	(King's College London)
KIT	(Karlsruhe Inst Technology)
UV	(Univ Valencia)
VITO	(Flemish Inst Technological Res)
ARSO	(Slovenian Env Agency)
NIMH	(Bulgarian Inst Met and Hyd)

Training: use of MSG toolbox

Operational meteorology: heat waves, temperature trends, extreme events

Cooling/public heating: urban heat islands

Forestry management

LSA SAF Applications

Electricity generation: solar power plants

Road management: icy roads

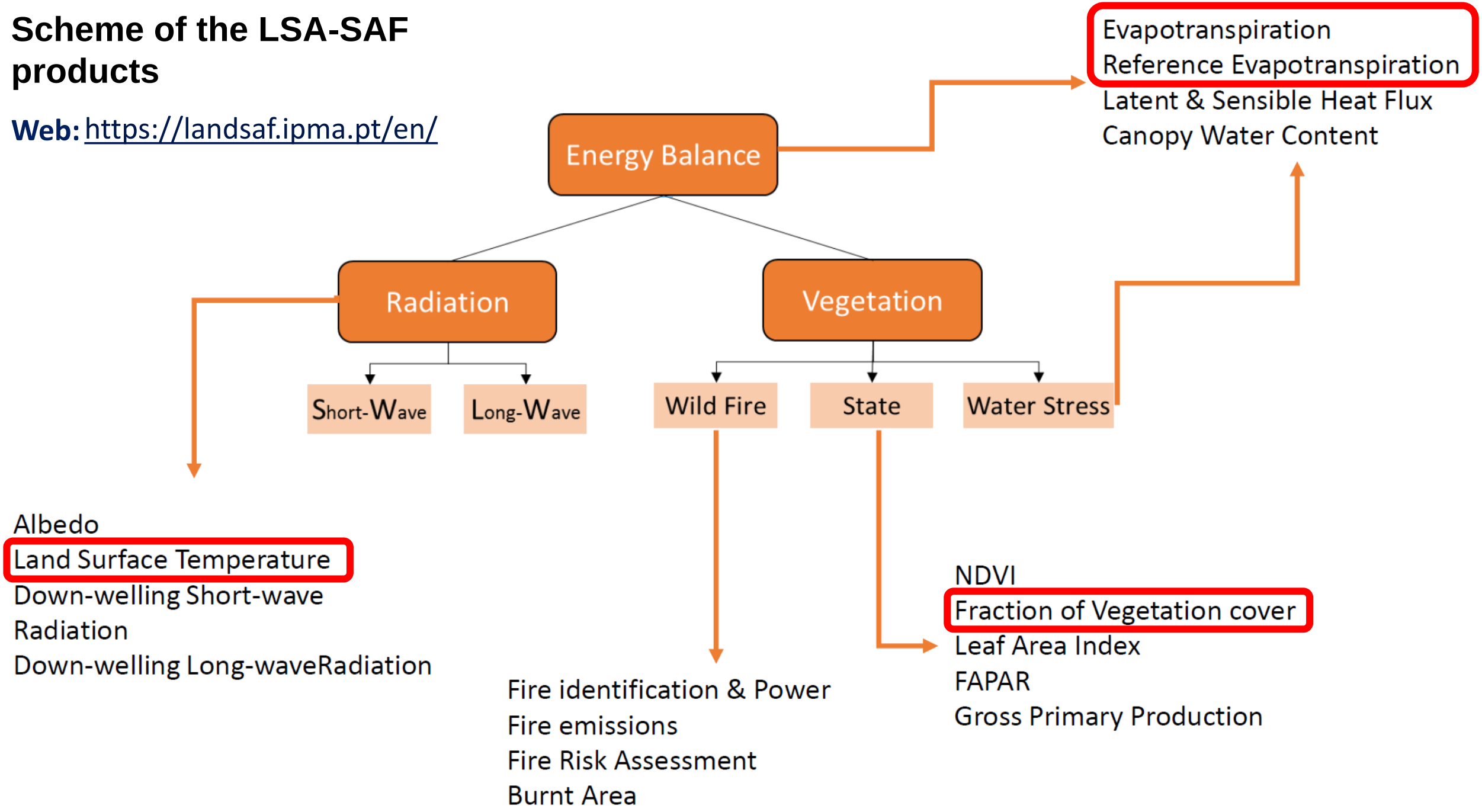
Civil protection: wild fires

Climate studies: validation/intercomparison

Agrometeorology: drought monitoring, frost exposure vegetation monitoring

Scheme of the LSA-SAF products

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



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Applications

FORESTRY & WILD FIRES

RENEWABLE ENERGY

AGROMETEOROLOGY

OPERATIONAL METEOROLOGY

CLIMATE STUDIES

NATURAL HAZARDS

Latest News

New operational data access service and discontinuation of website orders — March 24, 2023

New LSA SAF data access service becomes operational

The Largest Wildfire in Slovenia in Recent Decades — Jan. 18, 2023

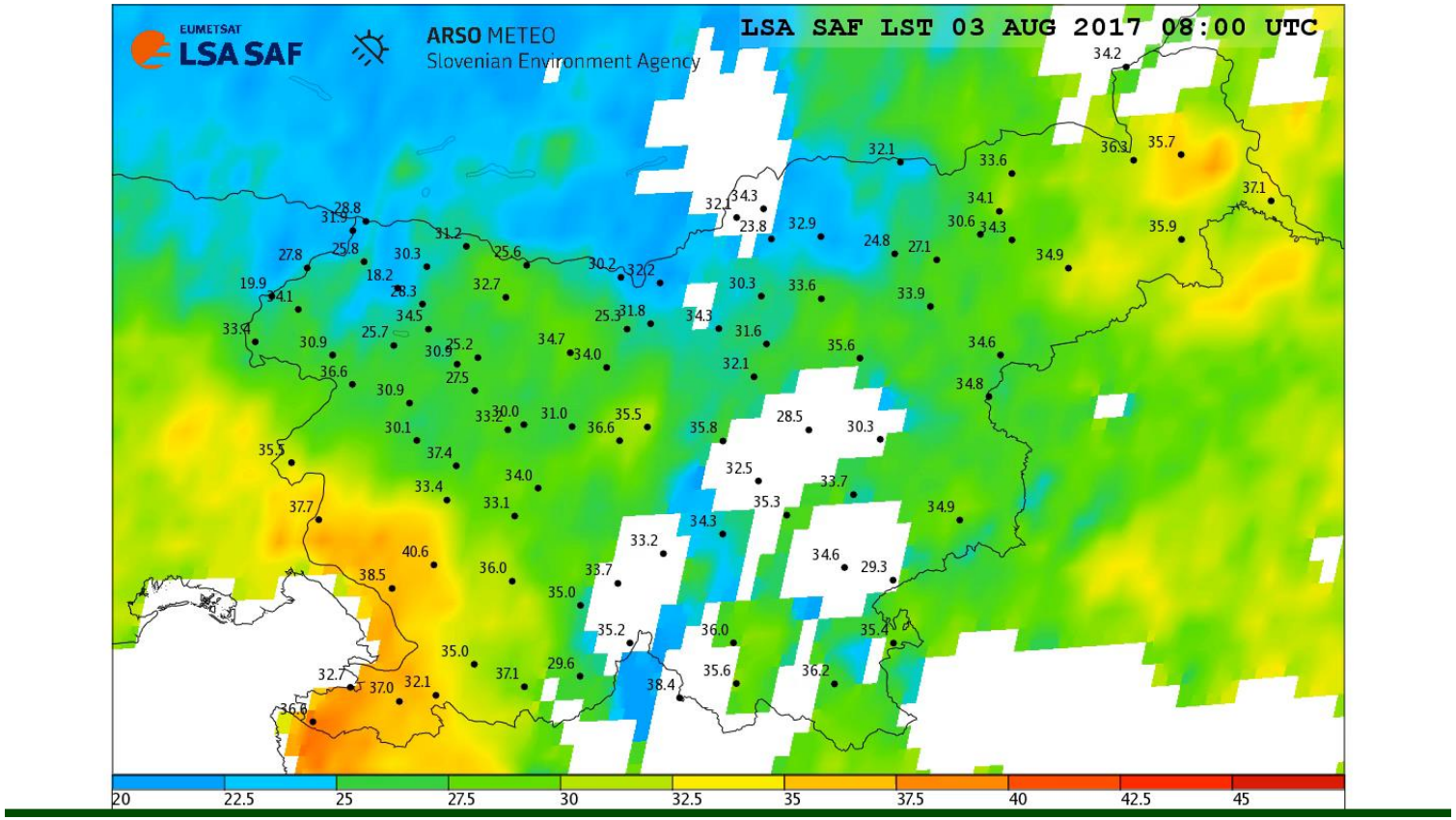
Analysing Fires with LSA SAF Fire Radiative Power Pixel

Satellite Detected Fires over Europe in 2022 — Nov. 11, 2022

Analysing fires with LSA SAF Fire Radiative Power in the summer fire season

Land surface temperature

Heatwave over Slovenia (2017)



Europe experienced a severe heatwave in early August 2017 (»Lucifer«). Air temperature > 40°C in many parts of Southern Europe!

LSA SAF MLST is

- ✓ *beneficial in places with limited in-situ coverage or in areas with diverse topography*
- ✓ *well suited to monitor ground conditions and to locate the hottest areas during heat waves*
- ✓ *useful to indicate areas over where convection might occur in pre-convective envirnoment*

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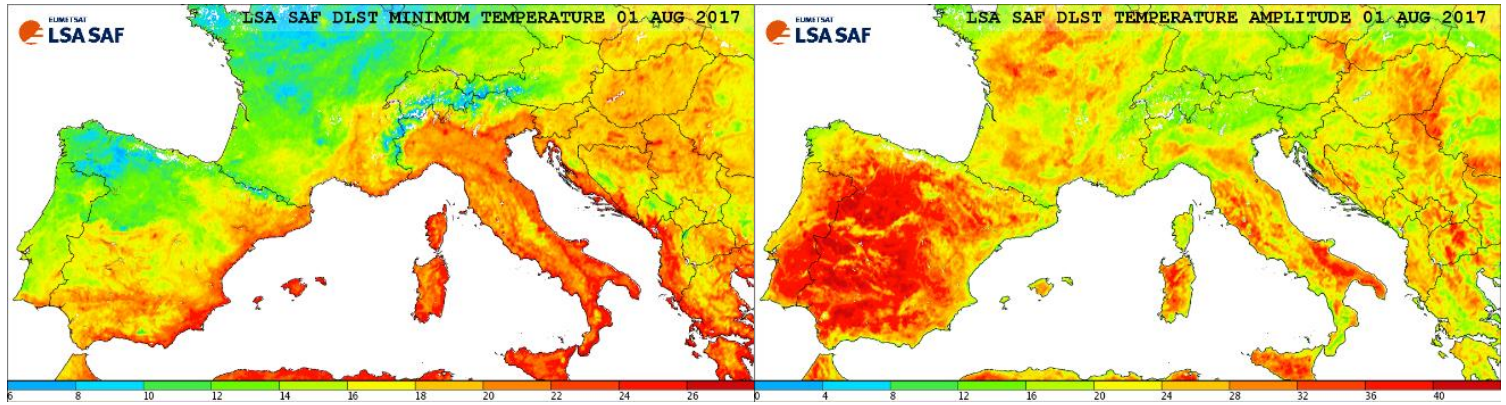
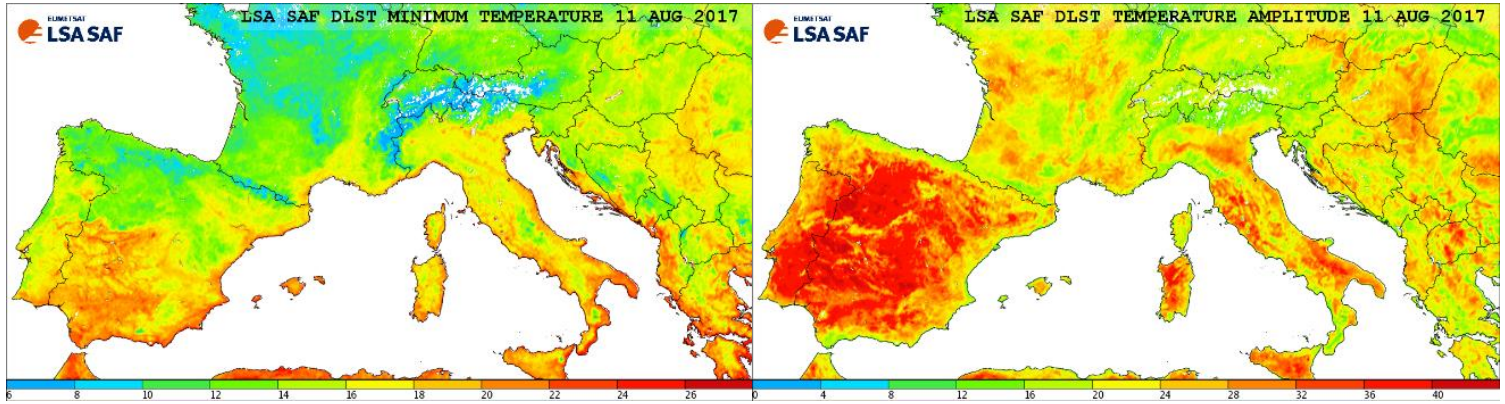
Heatwave over Southern Europe (2017)



LSA SAF DLST (Derived LST) provides an excellent overview of weather conditions in 10 day periods!



LSA SAF DLST's strengths

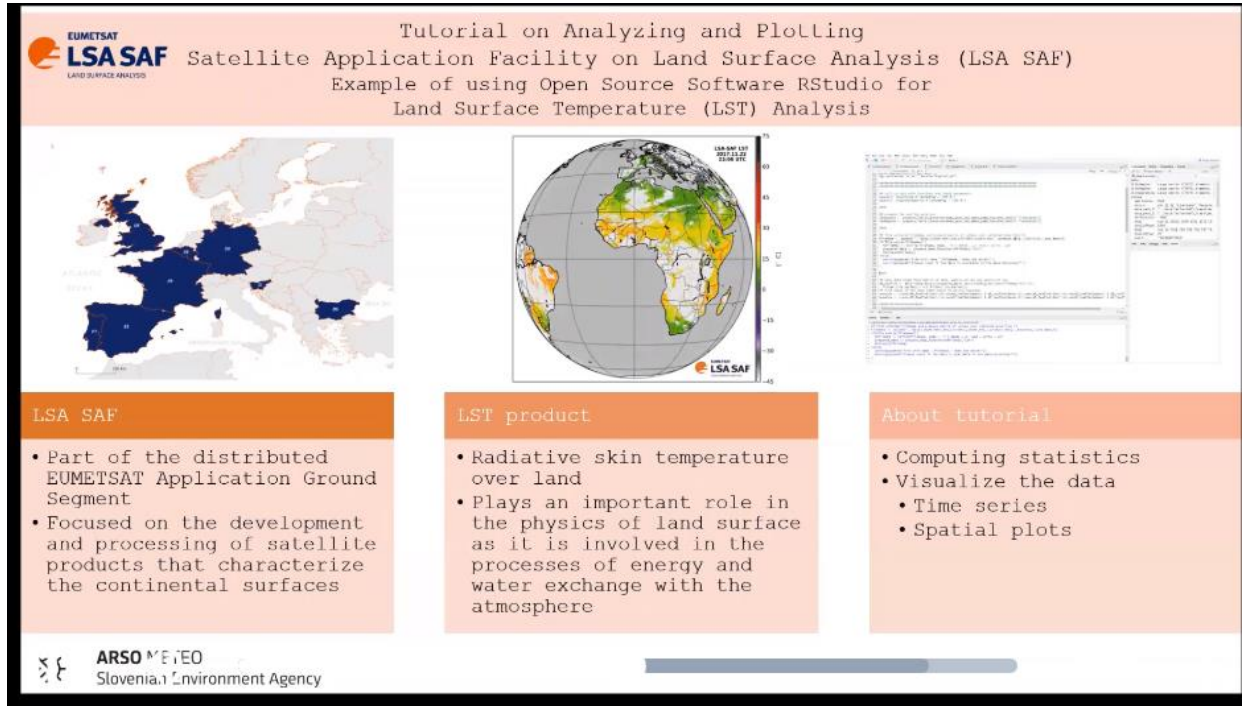
- ✓ perfect for quick temperature outlook in the last 10 days without any problems with cloudiness
- ✓ a very helpful indicator of past weather conditions (it allows us to identify heatwaves and droughts)
- ✓ good for agrometeorological/climatological analyses and analyses of more persistent weather conditions

Tutorial – Ordering LSA SAF LST

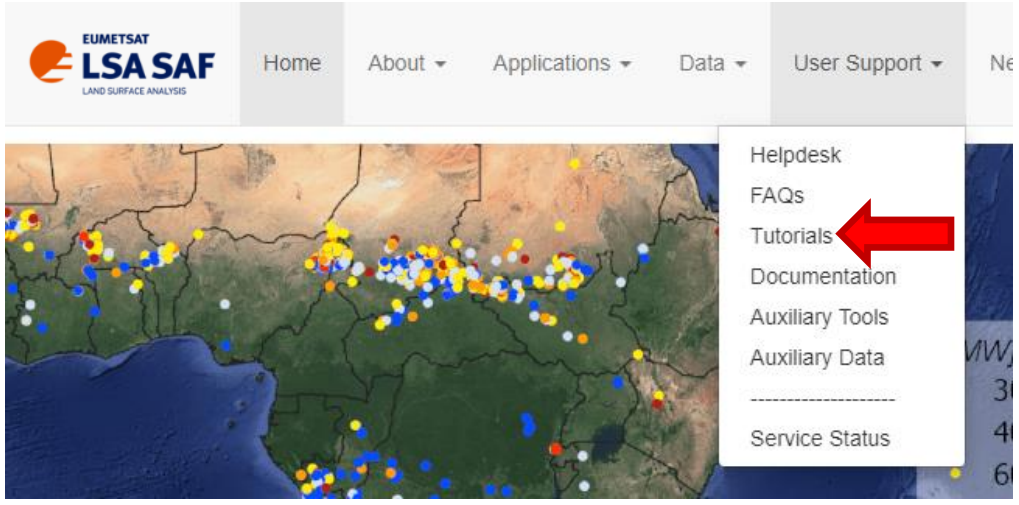
A tutorial on how to **order, analyze and visualize** the Land Surface Temperature (LST) product, including **video tutorials** with practical examples **of data handling with RStudio**.

Video tutorials on usage of [LSA SAF Land Surface Temperature data (LST-004)] **to compute different statistics, as well as for visualizing spatial data, plotting time series.**
Code and data for this tutorial available [here].

[Click to access tutorials]/

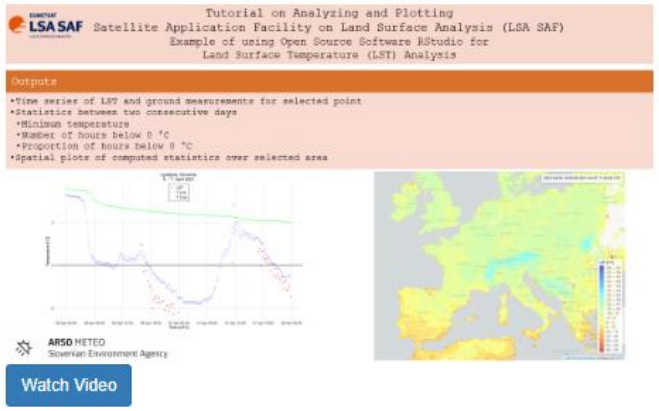


- **Tutorial on Analyzing and Plotting LSA SAF Products**
- **Example of using Open Source Software RStudio for LST Analysis**



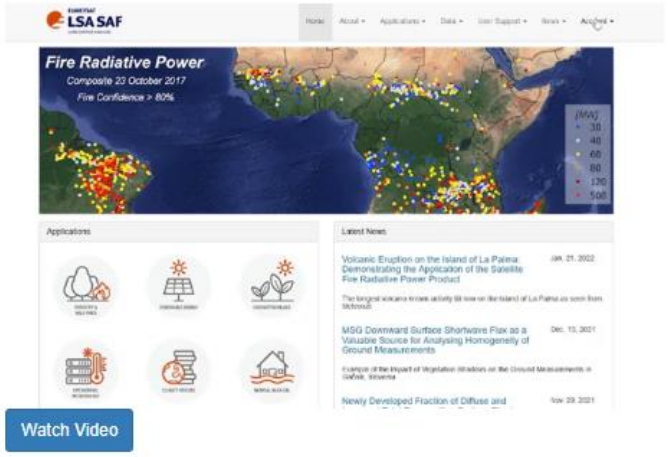
[RStudio] IDE of the [R programming language].

Tutorial – Processing LSA SAF LST



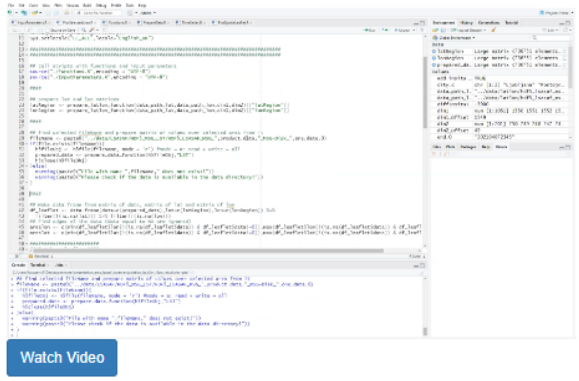
Presentation of the tutorial

- Introduction to the tutorial
- Overview of the tutorial



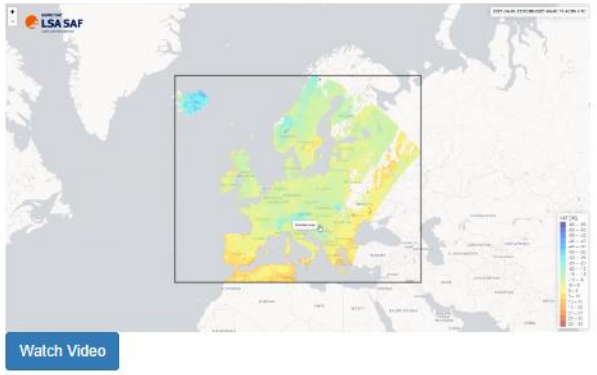
Registration on the LSASAF website, access and extraction of the data

- Registration on the website
- Accessing and ordering LST data
- Downloading auxiliary geolocation data:
  - longitude, latitude
- Extraction of the data



Presentation of the directory structure and R script for input parameters

- Directory structure explained
- Explained InputParametrs.R script
  - libraries
  - parameters for spatial plots
  - selected points for time series
  - selected product
  - selected timestamps
- Explained PlotSelectedArea.R script
  - preparing LST data
  - preparing longitude and latitude matrices
  - making a raster object
  - plotting selected area with leaflet



Presentation of R script for computing timeseries, statistics and plotting spatial data

- Explained Functions.R script
  - extraction, saving and plotting LST data
- Explained PrepareData.R script
  - prepare data for spatial plots
  - prepare data for time series
- Explained TimeSeries.R script
  - plotting time series of LST and in-situ data
- Explained PlotSpatialLeaflet.R script
  - prepare few statistics on selected area
  - plotting statistics with leaflet

Click to access tutorials

RStudio IDE of the R programming language.

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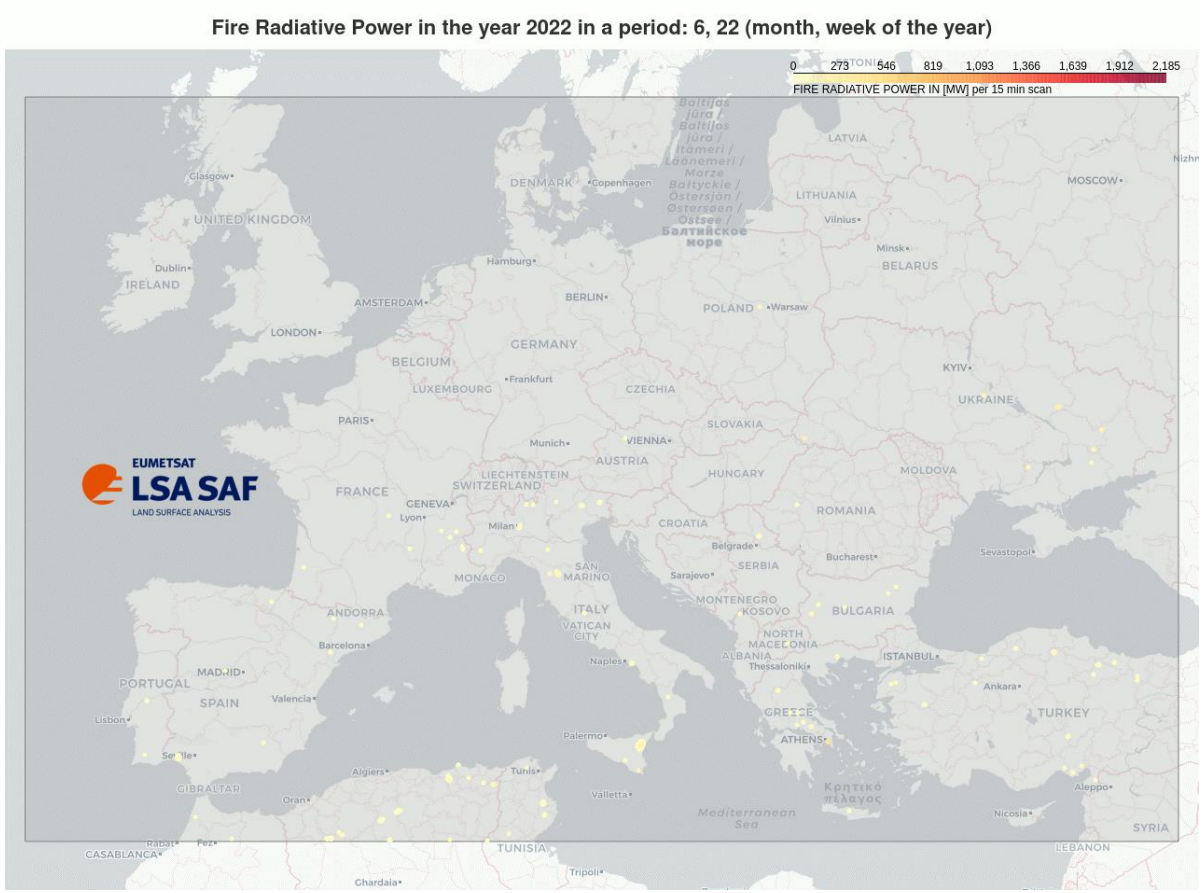
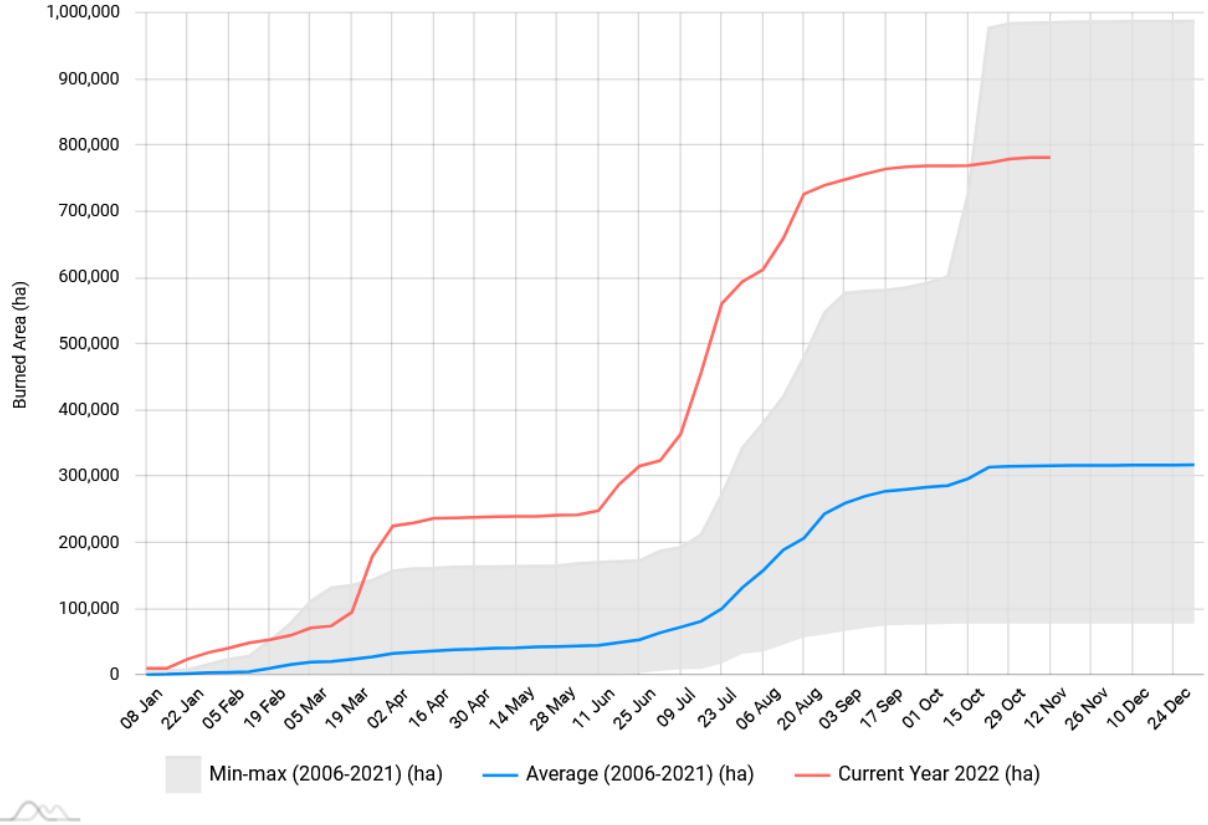
Fire Activity over Europe, 2022





© EFFIS (European Forest Fire Information System)

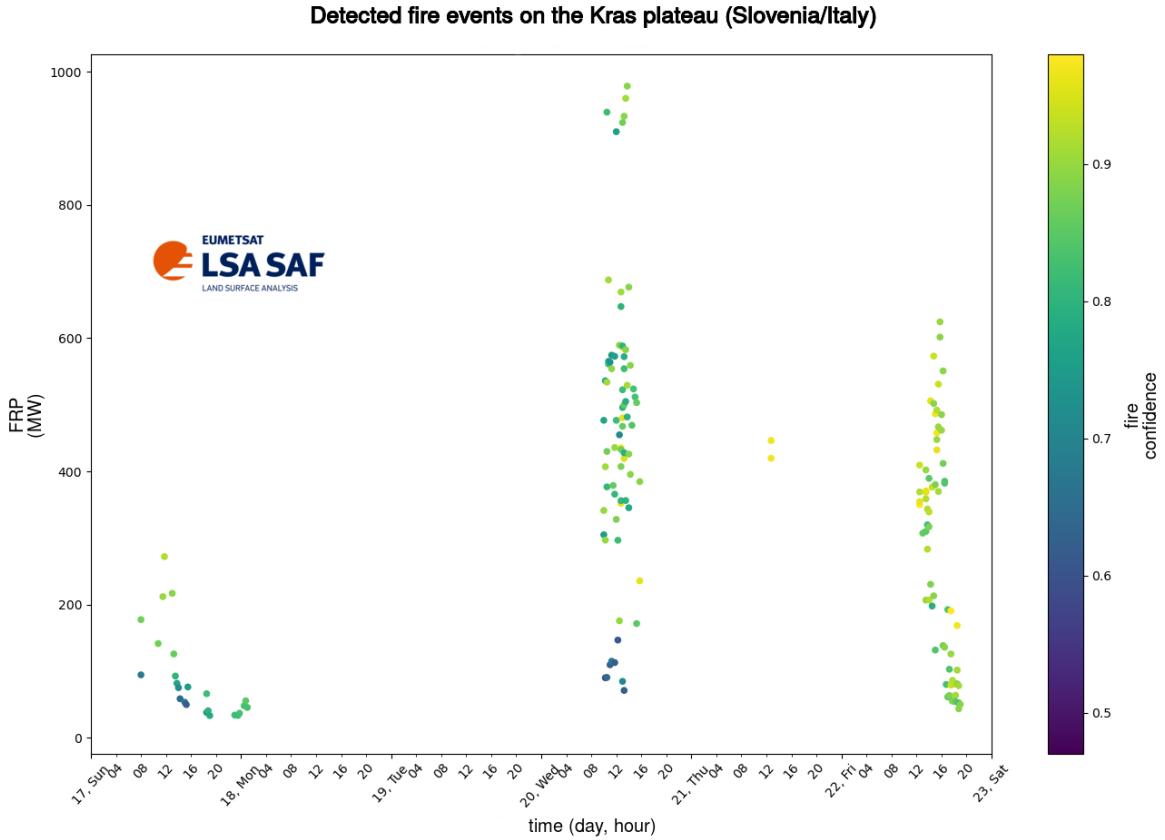
LSA SAF FRP (fire radiative power pixel) product is used to assess the extent of fires in the 2022 summer fire season.

Burnt area in 2022 (Europe) ~ **8,000 km²**

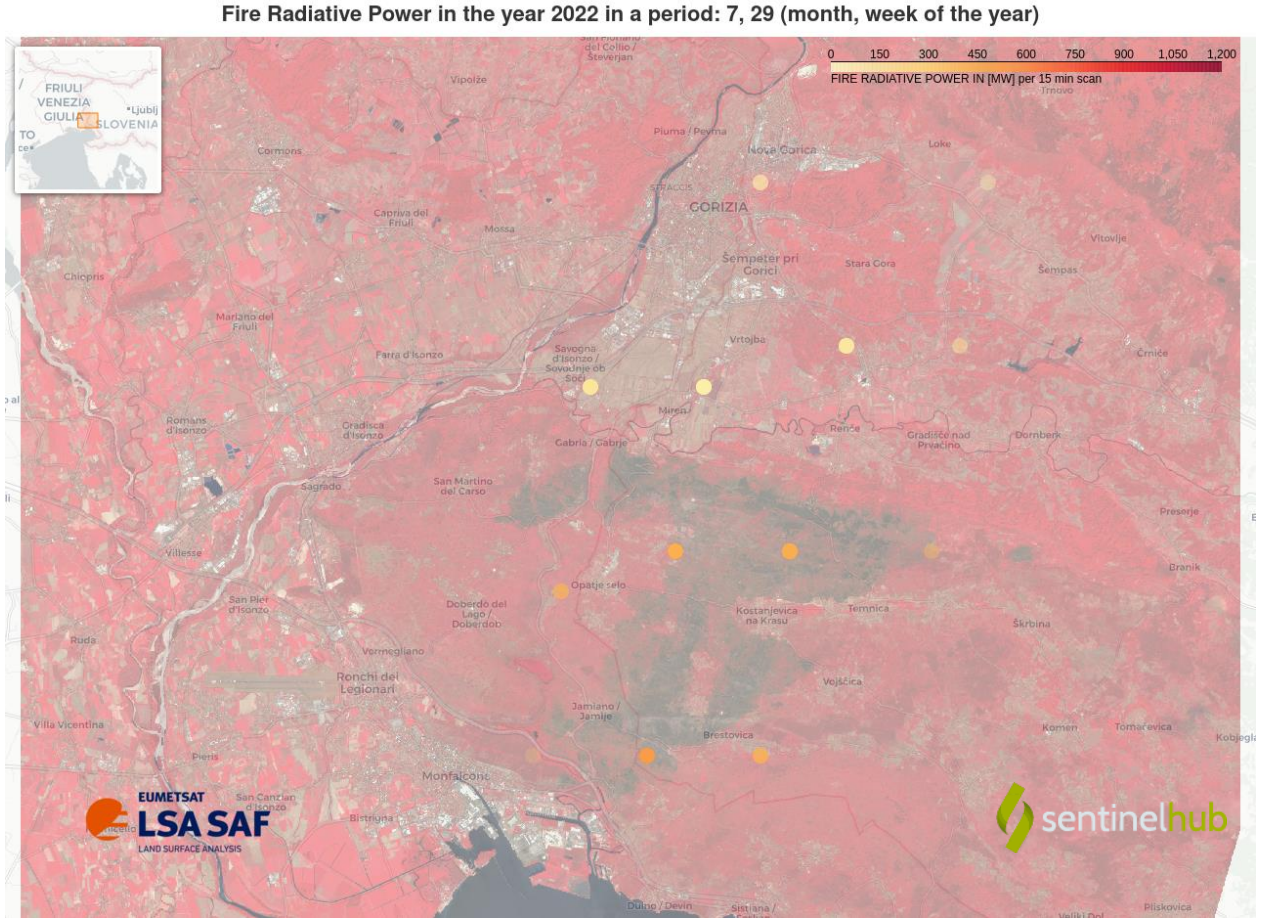
Fire danger is spreading northwards!

A Large Fire in Kras, Slovenia/Italy, July 2022

Very high temperatures and longer dry periods are becoming more and more frequent and consequentially fire danger is rising in the Mediterranean as well as in other parts of Europe.



LSA SAF FRP PIXEL: *fire radiative power (in MW) and fire confidence for July 2022; Kras, Slovenia/Italy.*

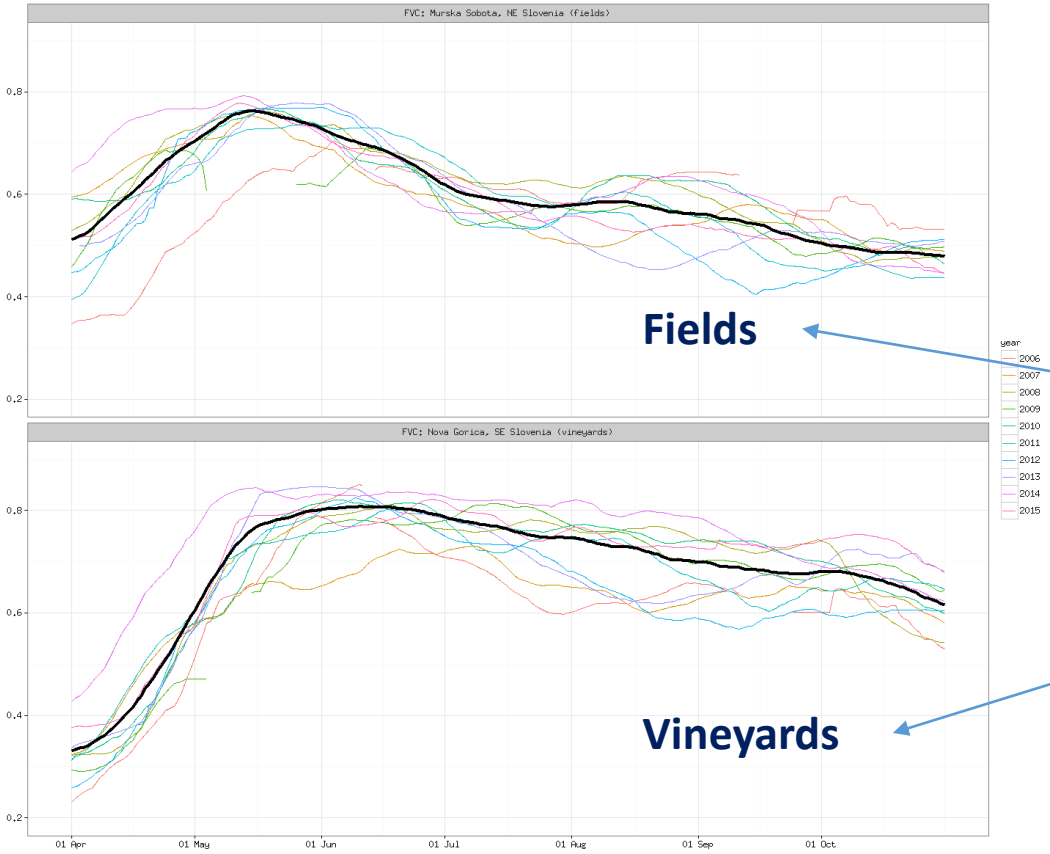


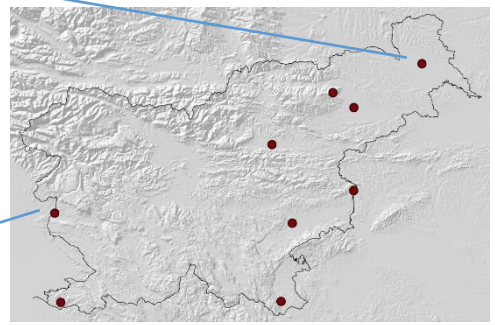
LSA SAF FRP PIXEL: *active fire pixels and fire released power*
Copernicus Sentinel 2 false colour: *burnt area*

Vegetation and droughts

LSA SAF Vegetation Products

At ARSO we rely on LSA SAF satellite products for drought and vegetation monitoring. LSA SAF products focus on the use of EUMETSAT satellites.





MSG/METOP VEGETATION INDICES (daily / multi-day temporal frequency):

- Fraction of vegetation cover (FVC)
- Leaf Area Index (LAI)
- Fraction of Photosynthetically Active Radiation (fAPAR)

LSA SAF FVC index

Reference based on long-term average vegetation (2004–2018).

Murska Sobota (NE Slovenia, fields)

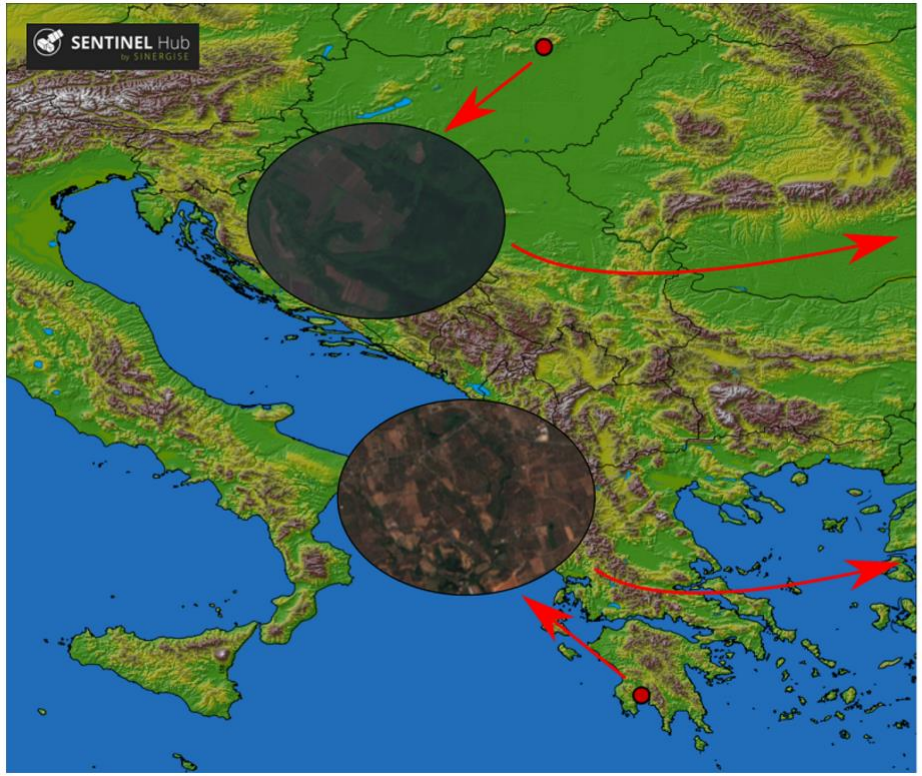
- Very dry years: 2007, 2012 and 2013 (summer values below reference)

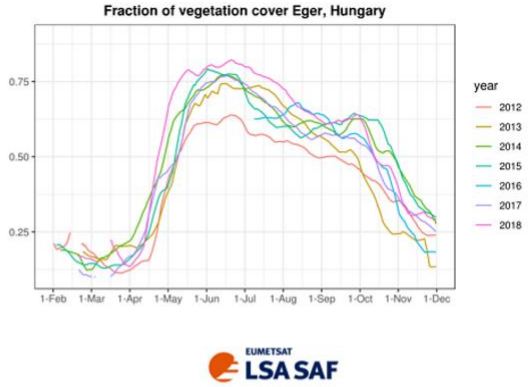
Nova Goria (SW Slovenia, vineyards)

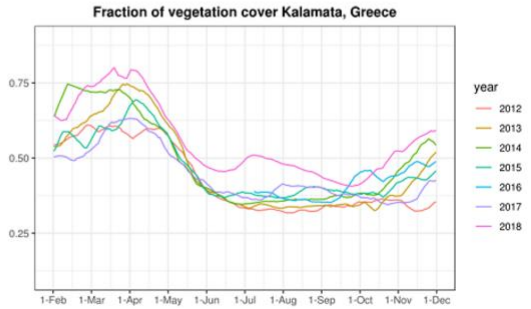
- Very dry years: 2006, 2007, 2012 and 2013
- A very moist year with high precipitation: 2014 (values well above reference)

Vegetation Response Variability

Vegetation signal from space (LSA SAF FVC from MSG) depends on various factors, such as growing season, water availability and vegetation type.







- Vegetation is at its greenest in late spring and early summer in Eger, Hungary (mixed vegetation types; continental climate).
- Kalamata, Greece (olive groves; Mediterranean climate): vegetation is green in spring and brown in summer.
- The two locations are located in different climate regions, which results in a large difference between vegetative season in Hungary and Greece.

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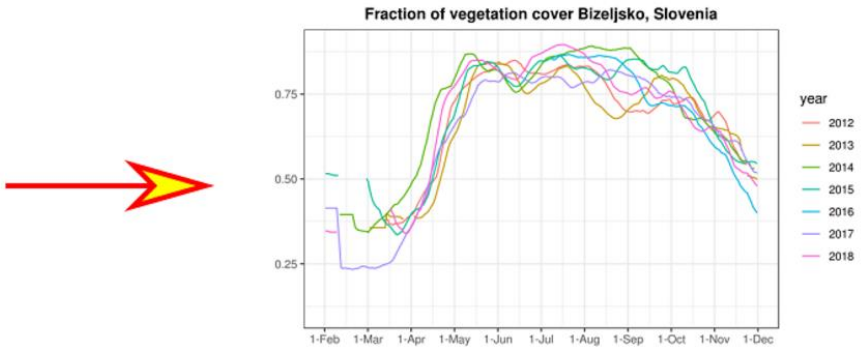
How do land and climate type affect vegetation signal from space?

LSA SAF FVC (from MSG) yearly evolution at two locations in Slovenia close to each other with a similar climate: Bizeljsko (mostly vineyards and forests) and Murska Sobota (crops).



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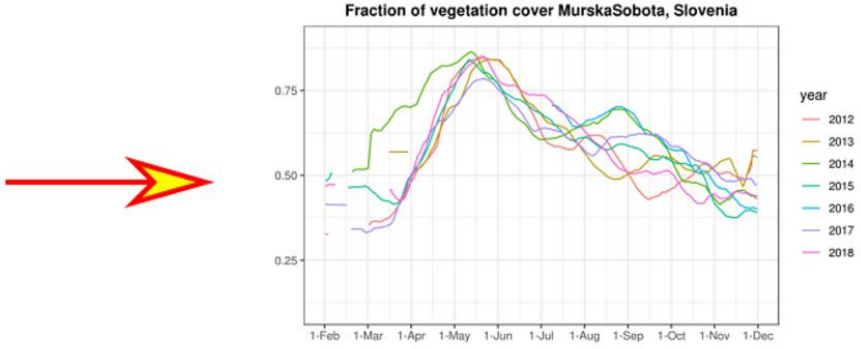


- Vegetation stays very green from late spring until the end of summer in Bizeljsko, whereas there is a peak of FVC in the late spring with decreasing FVC values later in Murska Sobota.
- Year-to-year FVC variability is a function of available water in the growing season and the types of crops that are grown on the cultivated land.
- Different land types cause differences in their respective satellite signals.

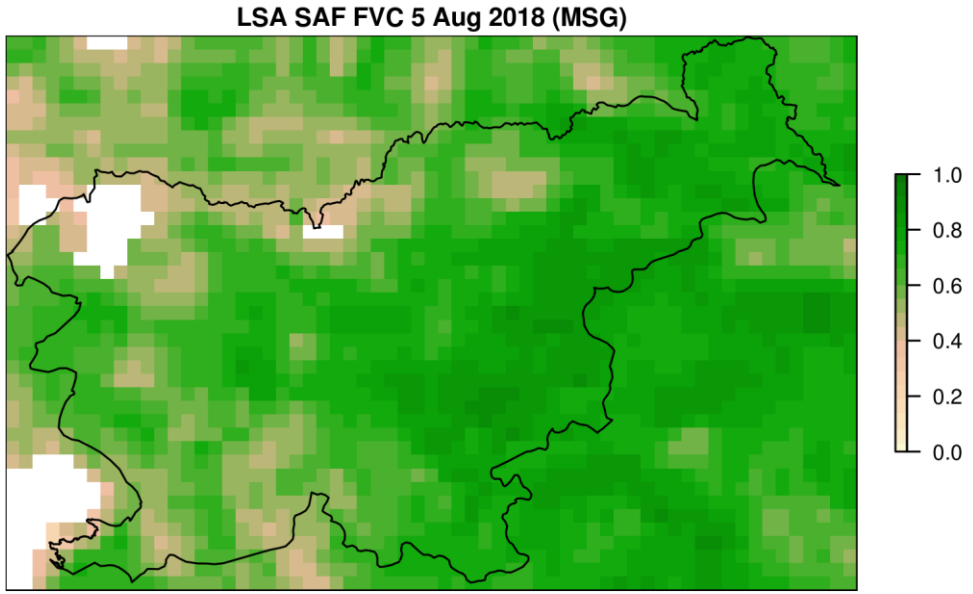
High Spatial Resolution Satellite Data

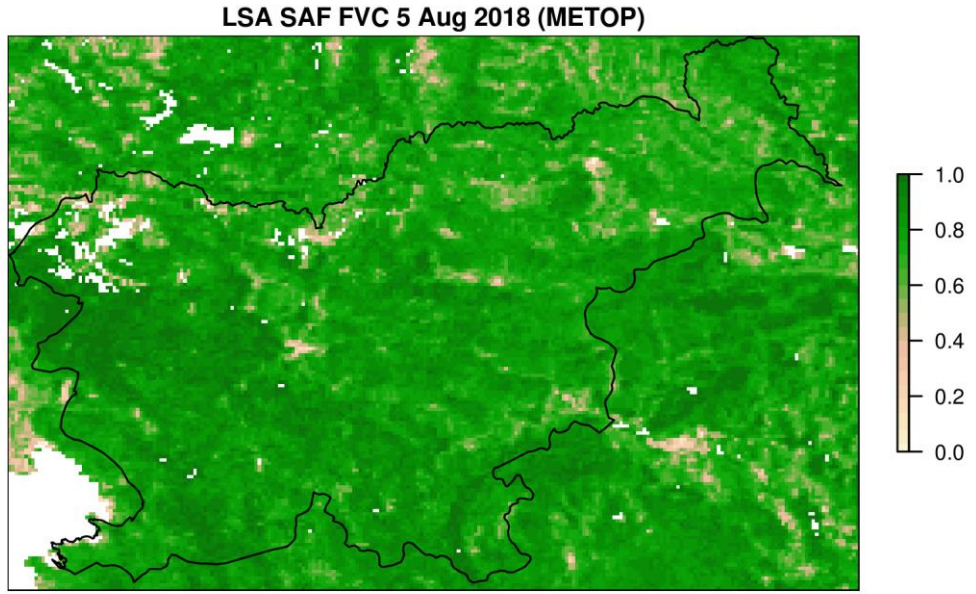
Frequency: daily
Spatial resolution: ~ 4km

Frequency: 10 days
Spatial resolution: ~ 1km

LSA SAF Fraction of vegetation cover (MSG)

LSA SAF Fraction of vegetation cover (METOP)





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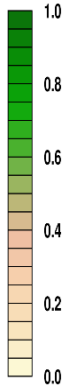
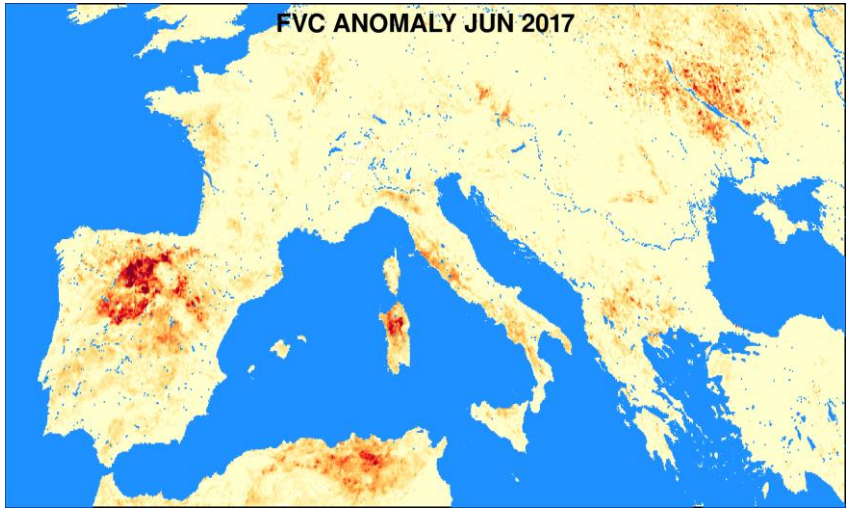
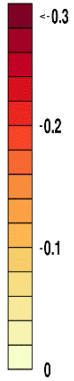
Fraction of Vegetation Cover: Locating Drought Impacted Areas

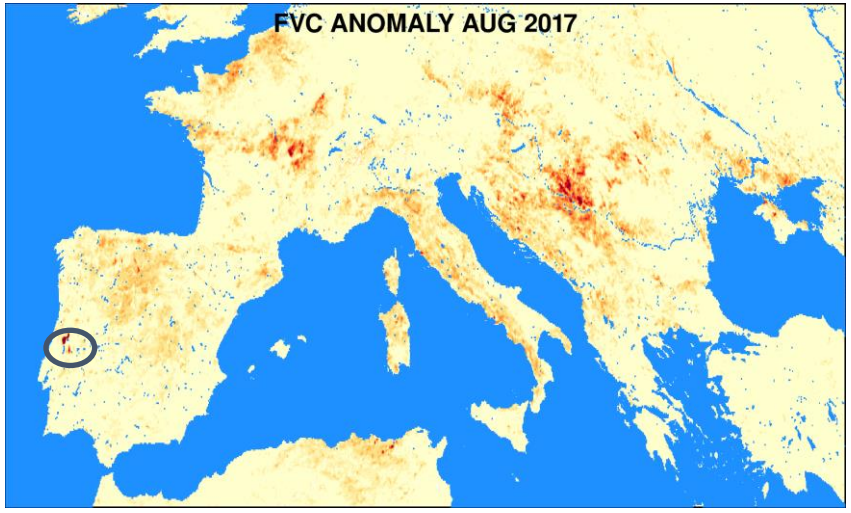


FVC and its negative anomaly (difference from average value) are displayed on the left.

Droughts: Iberia, Italy, France (middle/late summer) and the Balkans (late summer).







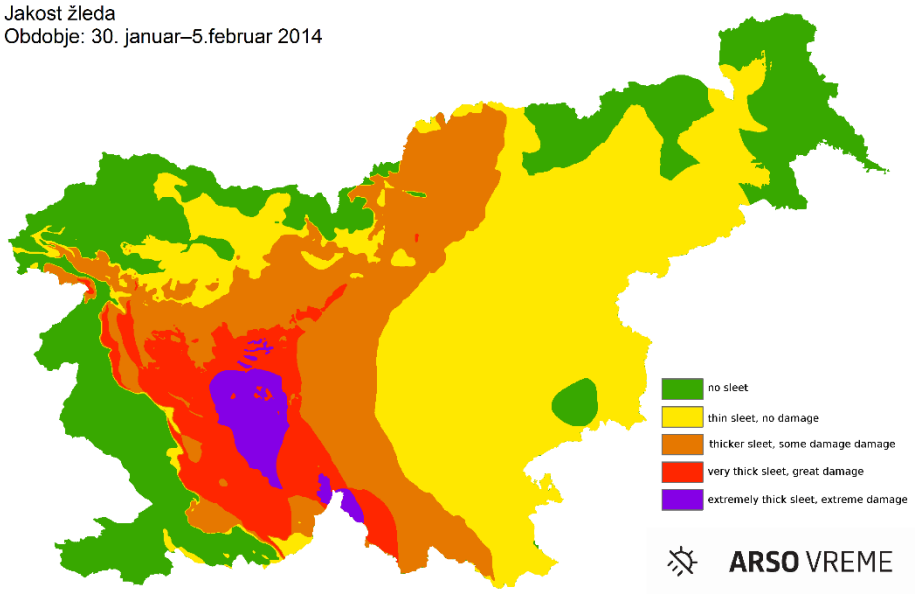
Areas of burnt forest in Portugal caused by massive forest wildfires encircled in black.

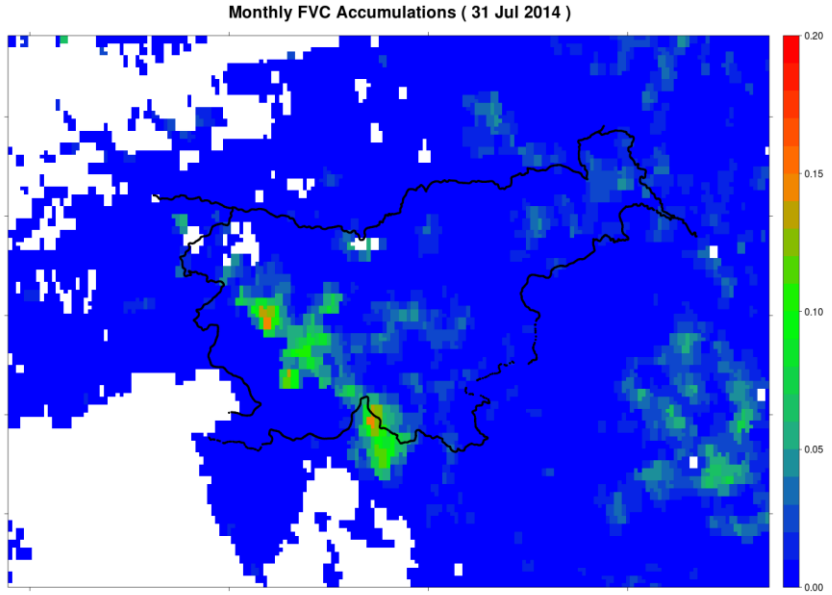
Locating Damaged Vegetation with FVC (Glaze Ice)

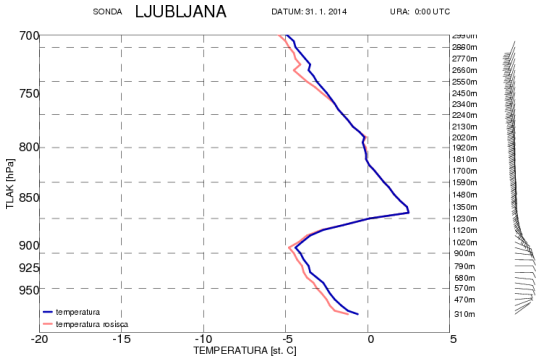
FVC also useful for detecting damage on vegetation not associated with drought, e.g., hail and glaze.

There is a fairly good spatial agreement between the glaze ice damage map and FVC, particularly in SW Slovenia suffering the worst of glaze ice!

Glaze ice damage, 2014







Pictures from Slovenian news (e.g. Delo)

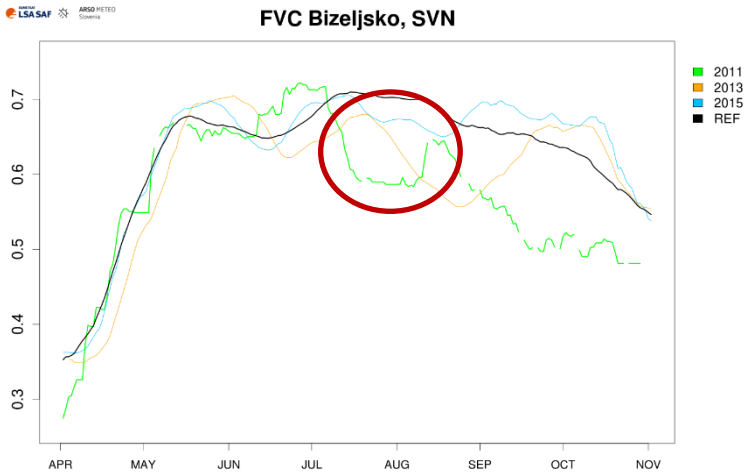
Glaze Ice (SW Slovenia), Jan/Feb 2014

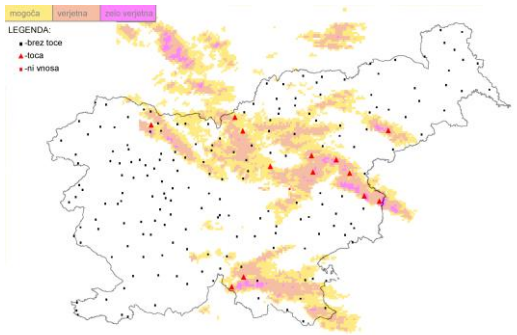
And below aftermath of the event a few months later …

(all pictures extracted from Slovenian news sources, e.g., Delo)

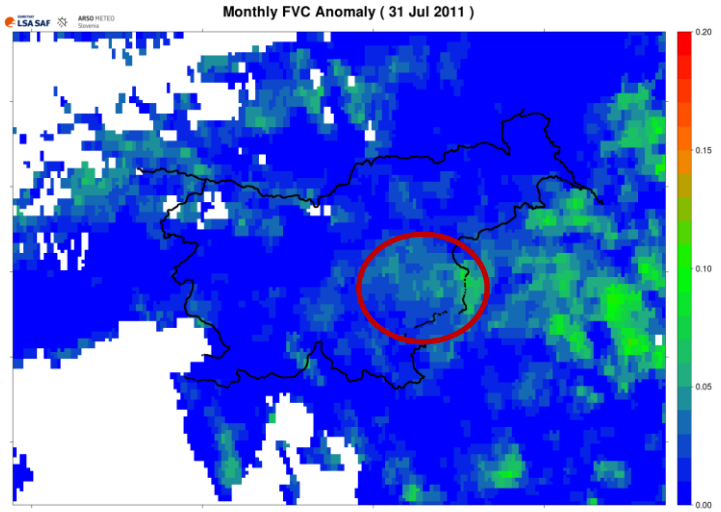
Locating Damaged Vegetation with FVC (Hail)

FVC also useful for detecting damage on vegetation not associated with drought, e.g., hail and glaze.





Hail damage, 2011



pictures from Slovenian news sources (www.bizeljsko.si)

Actual and Reference Evapotranspiration

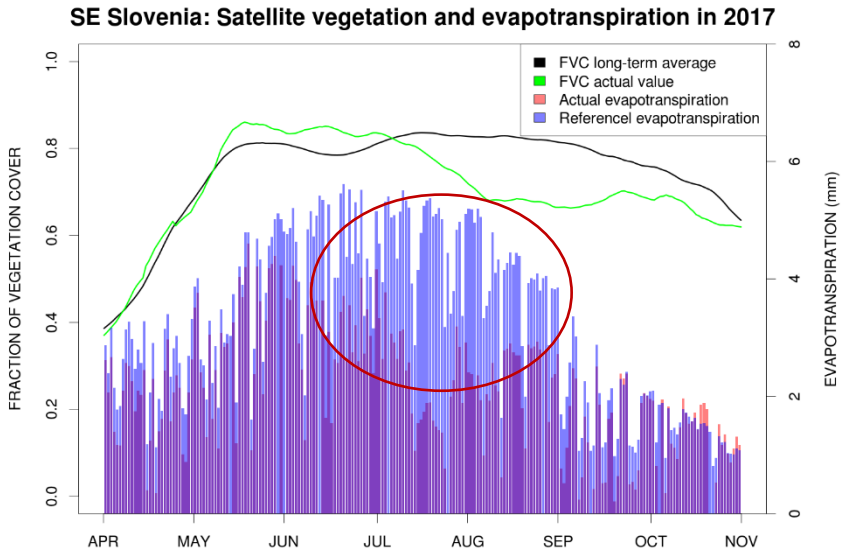
SEVIRI/MSG:

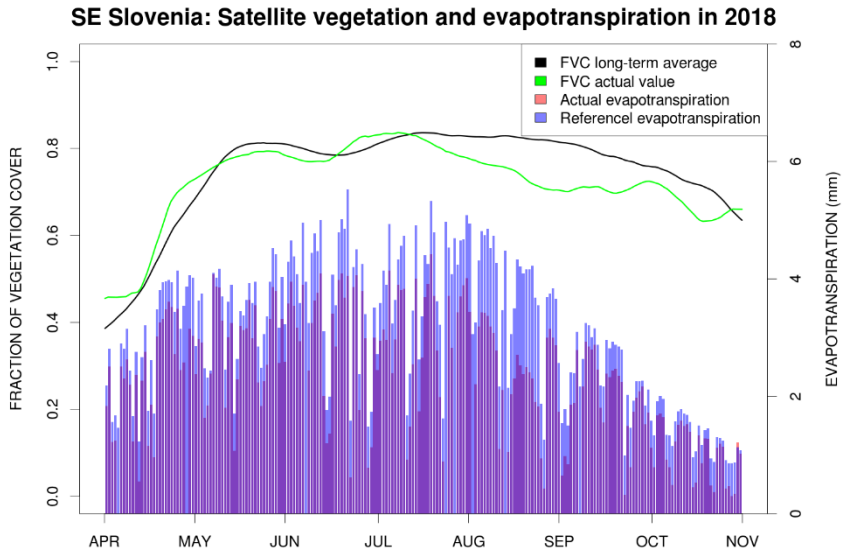
- **30 min / 3 km sub-satellite point**
- **Daily composites**

Actual ET: Energy Balance by cover type within **each pixel using SEVIRI down-welling radiation, Albedo, Vegetation, LST, ….**

Reference ET: Evapotranspiration of reference non-stressed surface driven by **DSSF**.

Large difference between actual and reference evapotranspiration signals drought.





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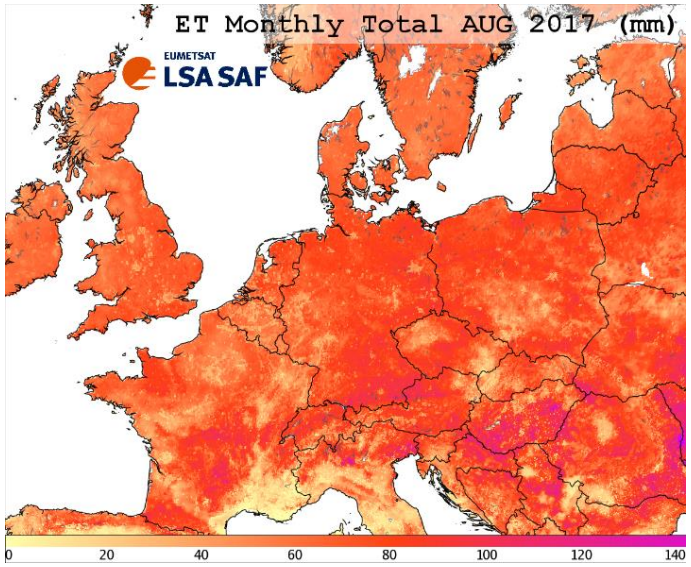
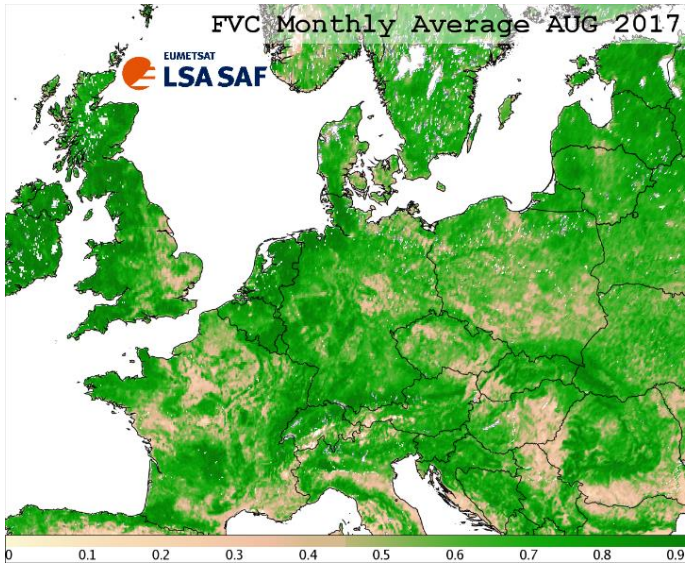
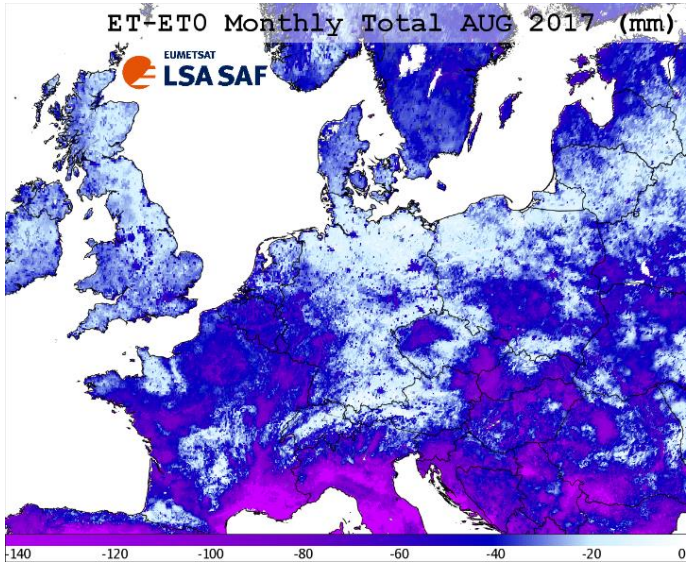
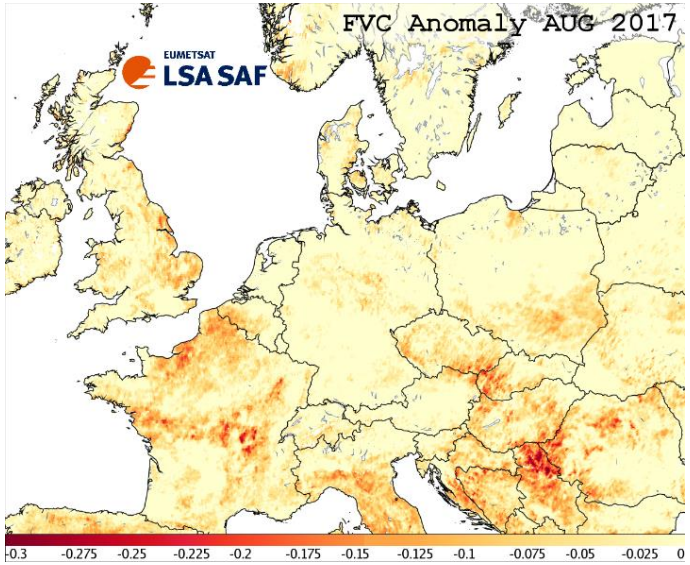
Combined Vegetation and Evapotranspiration Signal (2017)





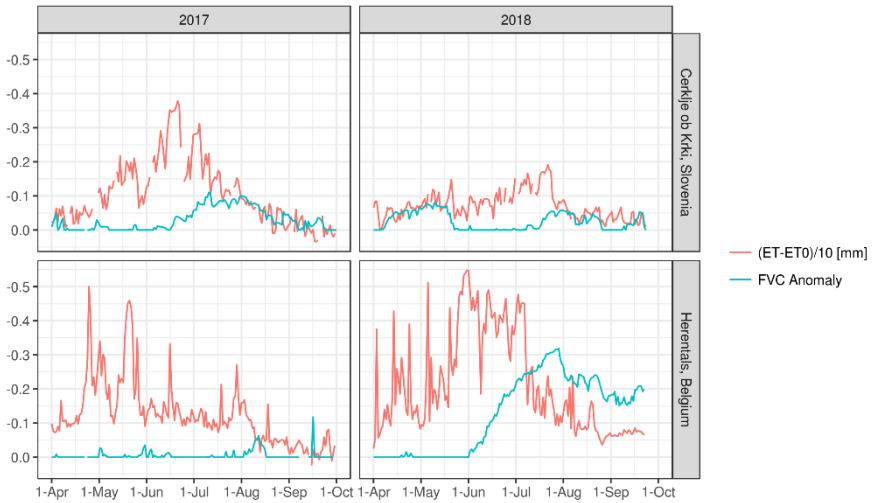




A combination of satellite ET and vegetation signal improves locating droughts.

ET drought signal often occurs before vegetation drought signal.

ET difference ($ET - ET_0$) and FVC anomaly both highlight that mostly areas of S and SE Europe experienced strongest drought in Aug 2017.



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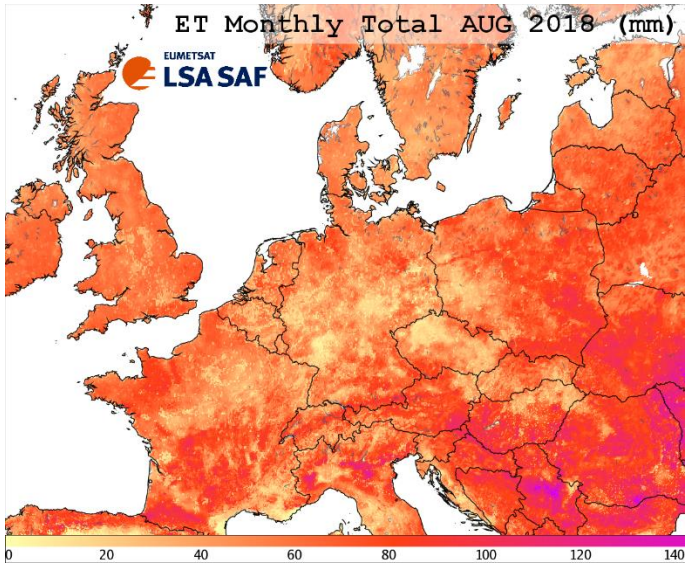
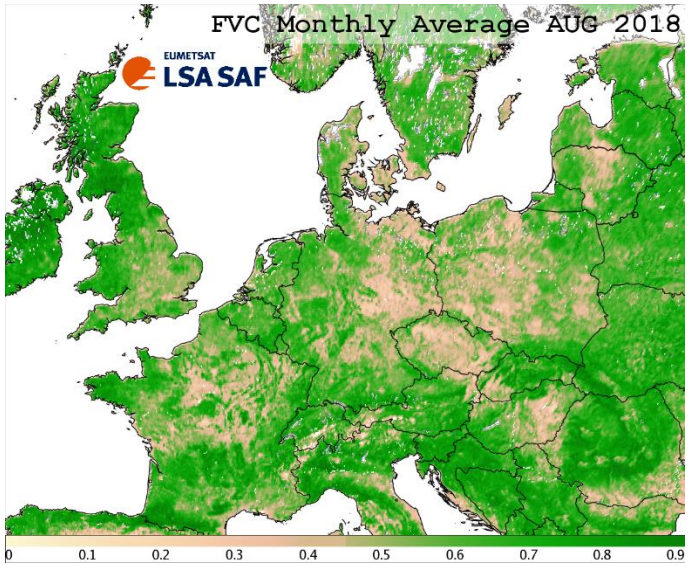
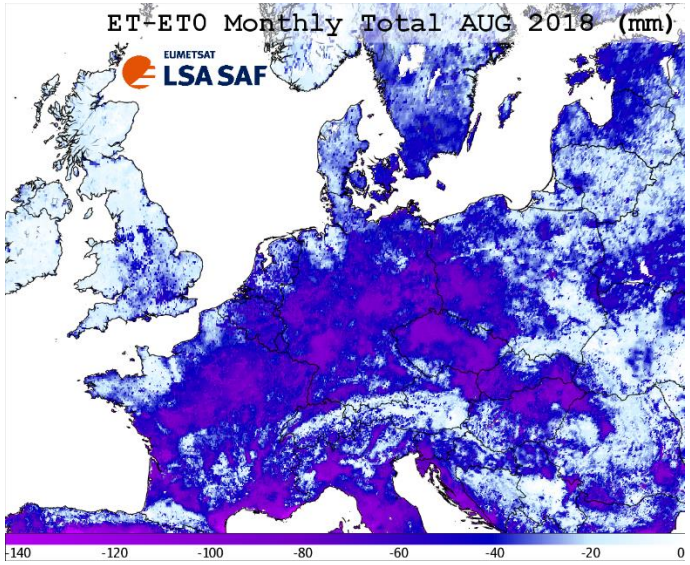
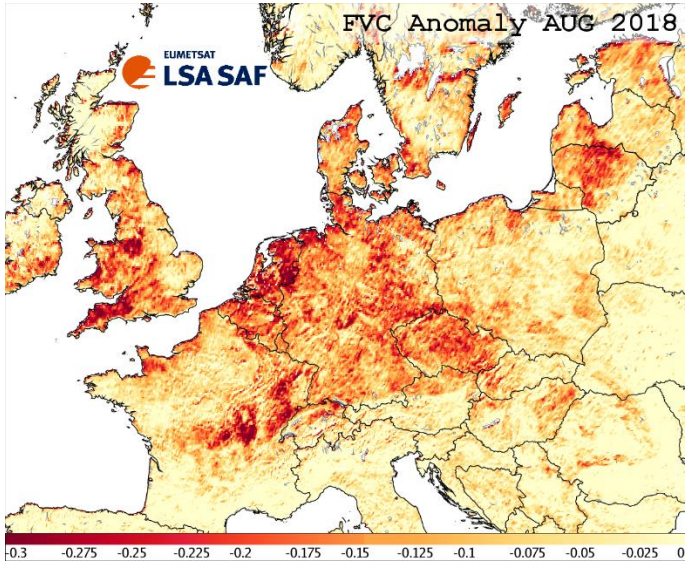
Combined Vegetation and Evapotranspiration Signal (2018)





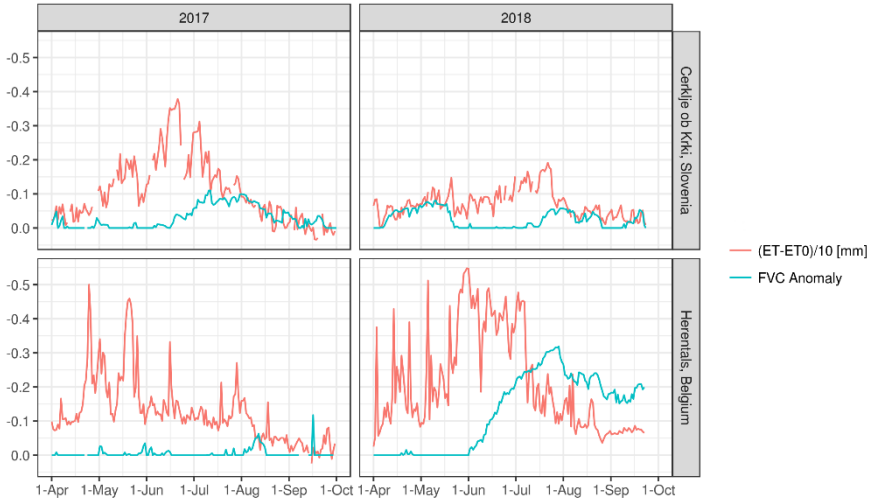




A combination of satellite ET and vegetation signal improves locating droughts.

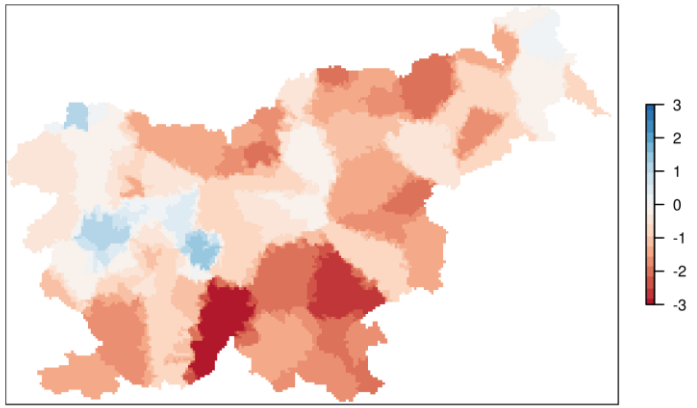
ET drought signal often occurs before vegetation drought signal.

In Aug 2018 vegetation and evapotranspiration drought signal is present in N, W and Central Europe.



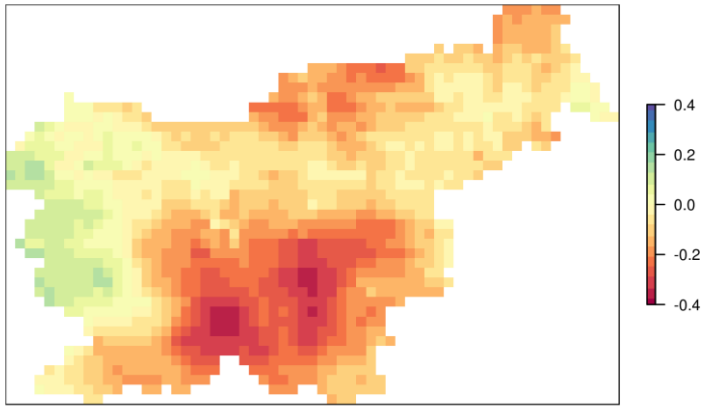
Combined Drought Monitoring Indices

SPI (3-monthly)

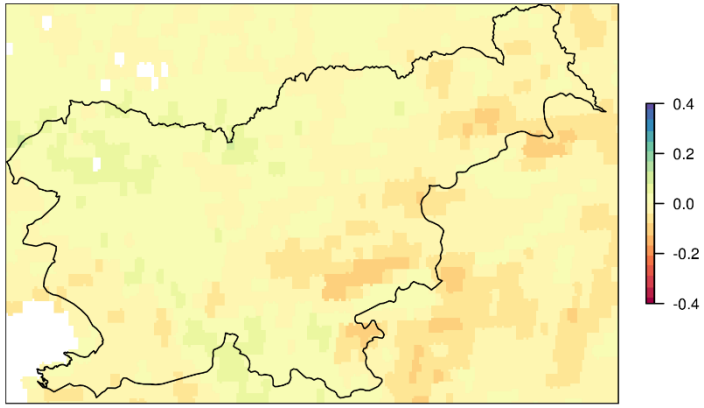


ET RATIO monthly anomaly

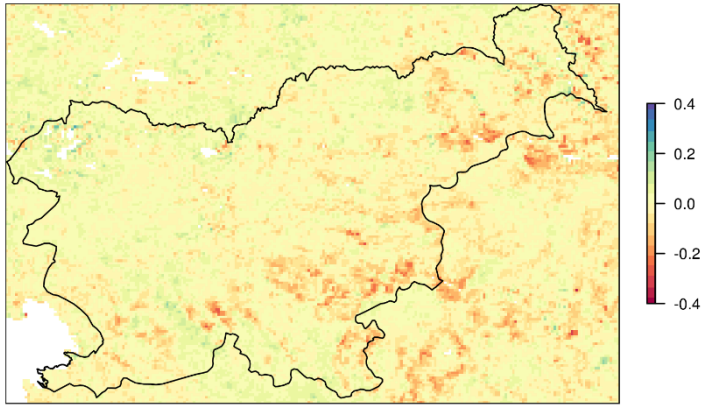
(MSG and ground data)



monthly FVC ANOMALY (MSG)

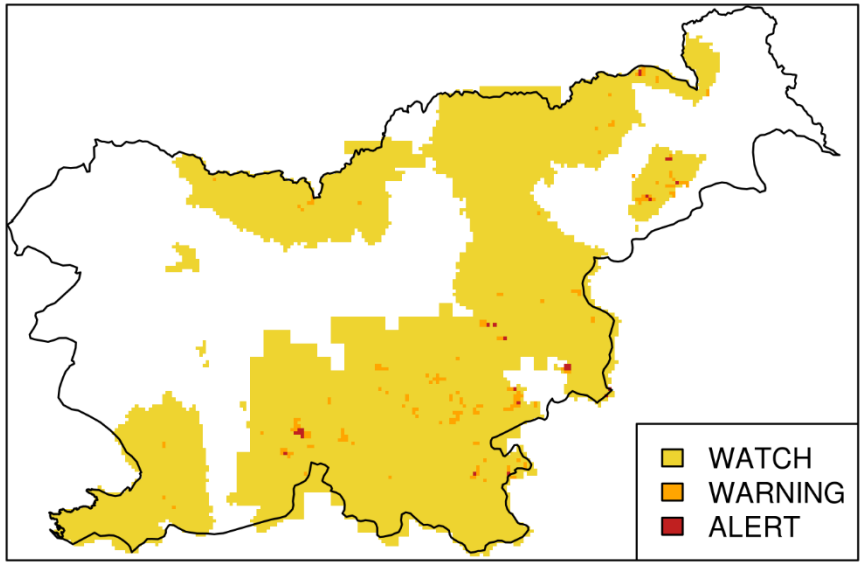


monthly FVC ANOMALY (METOP)

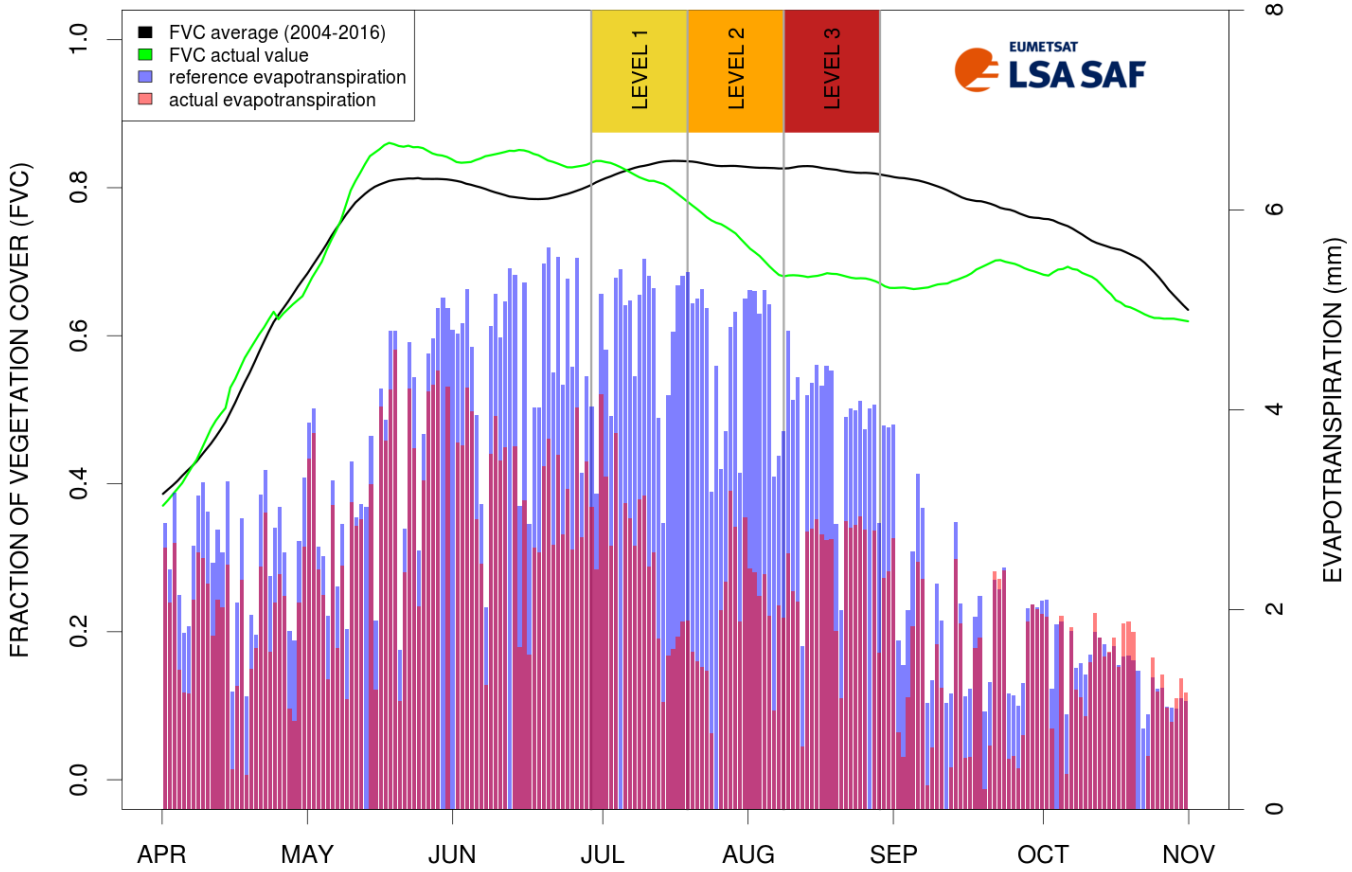


- **ET / ET_0 + SPI + FVC** anomaly
- tune regional thresholds for **WATCH**, **WARNING** and **ALERT** stage
- results over Slovenia, August 2017

Combined Drought Index (CDI)

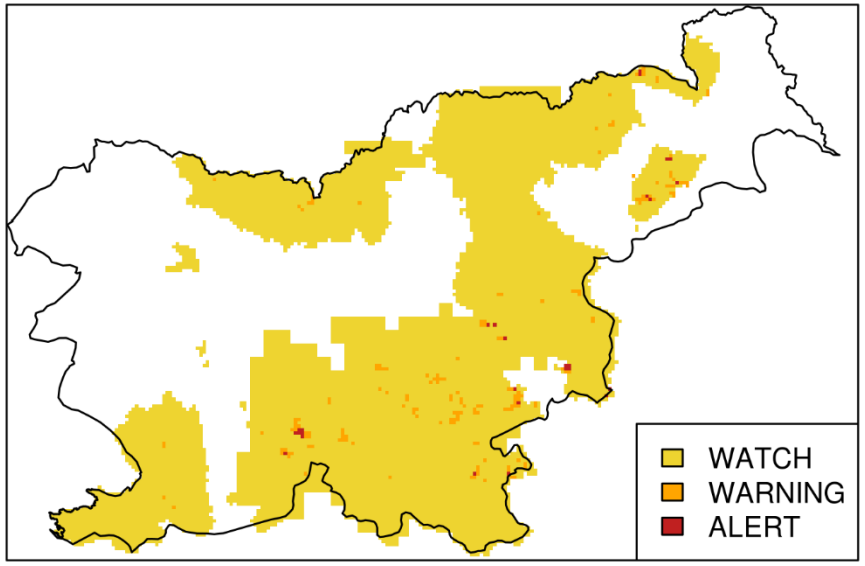


Combined Drought Monitoring Indices



- **ET / ET_0** + **SPI** + **FVC** anomaly
- set thresholds for **WATCH**, **WARNING** and **ALERT** stage
- results over Slovenia, August 2017

Combined Drought Index (CDI)



Thank you for your attention!

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