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Slovenian Environment Agency

The state of Slovenian drought monitoring and insights gained from the preparation of Jupyter Notebooks

Boštjan Muri, Ahac Pazlar, Vid Primožič, Mateja Iršič Žibert

Slovenian Environment Agency

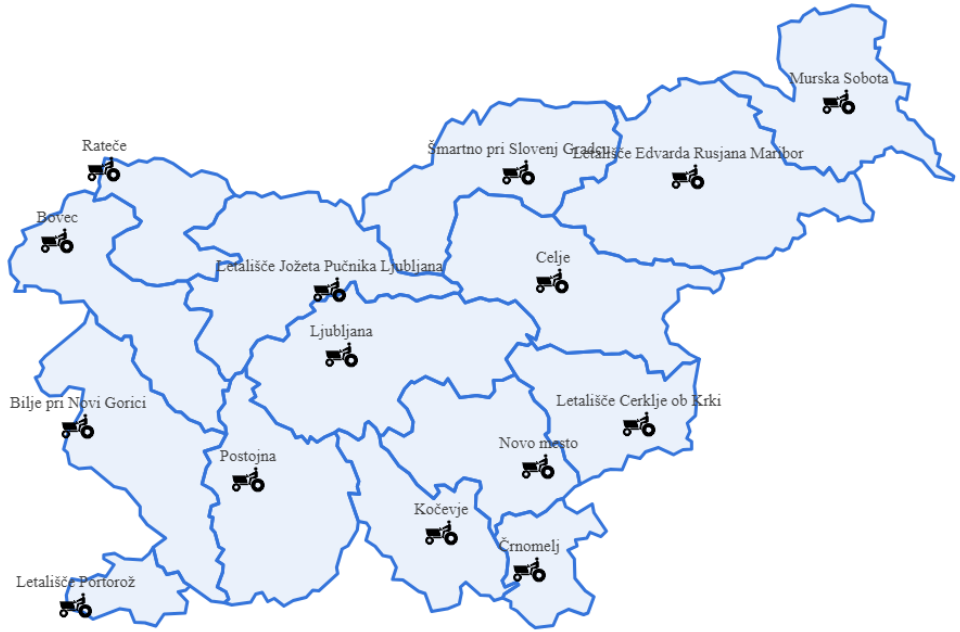
Outline

- **Drought management status in Slovenia**
- **Drought monitoring and satellite products**
- **Training activities – Jupyter Notebooks**
- **Jupyter Notebooks – lessons learnt**

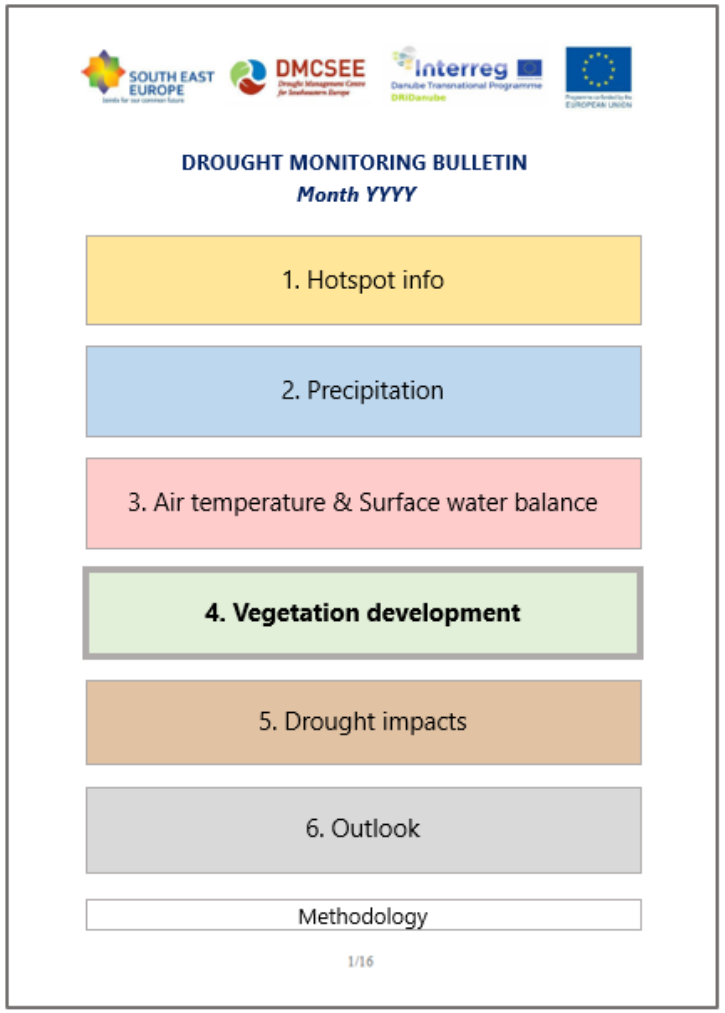
Drought management bulletins

Bulletins for monitoring and vulnerability risk assessment of droughts.

- **Drought Management Centre for Southeastern Europe**: www.dmcsee.org/
- **Drought Meter:** Agrometeorological forecasts for Slovenian regions



DMCSEE drought bulletins



- **DMCSEE** (Drought Management Centre for SE Europe) hosted by ARSO
- Web platform: www.dmcsee.org

Regular drought bulletins

- Monthly (March/April – September) & Seasonal overview
- 13 countries in **SE Europe**
- One of the topics in focus: vegetation development

Via: **LSA SAF MSG Daily Fraction of Vegetation Cover**

The goal is **improving drought preparedness and reducing drought impact**.

Coordinate and facilitate the **development, assessment and application** of drought risk management tools and policies.

DMCSEE bulletins – vegetation evolution

Daily FVC product used for

- current level of vegetation evolution against the long-term average
- comparison to similar years in the past

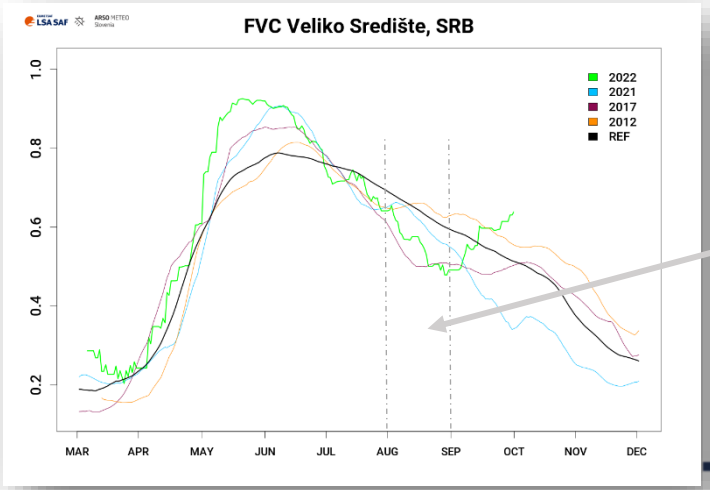
Maps included in the bulletin

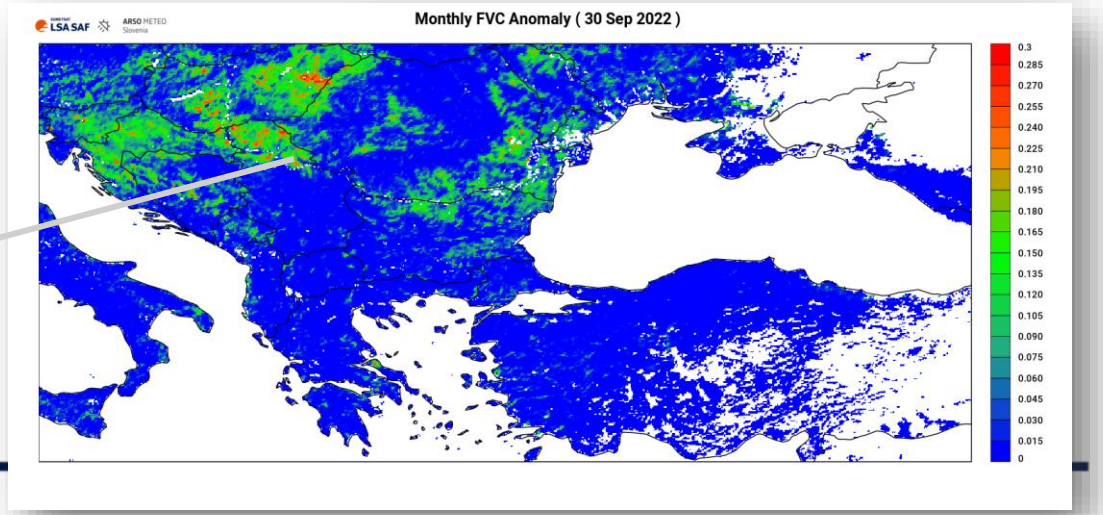
- FVC time series for 13 locations (permanent, non-cultivated, non-irrigated veg.)
- spatial maps of 30-day accumulated negative anomalies FVC

Observations based on the FVC daily evolution: examples

- cover is lower/more abundant than normal
- phase occurs earlier/later than normal
- rate of growth/senescence
- peak value and timing

Observing changes in veg. evolution due to droughts (not other factors)

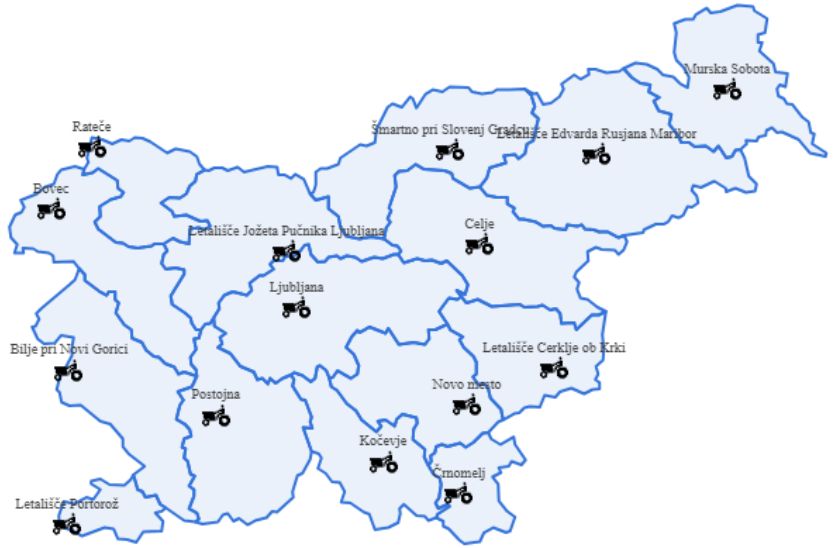




Regional agrometeorological bulletins

The goal is to support agronomical users.

- **Daily bulletin**
- **Regional information**
- **Meteorological and Agrometeorological information**
  - Weather alerts and outlook
  - Water balance
- **Remote sensing information under consideration**
  - Analysing in-situ ETP vs. LSA SAF METREF



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Regional agrometeorological bulletins

ARSO VREME

Agrometeorološka napoved Ljubljana in okolica

Splošne informacije

Skoči na:

- Splošne informacije
- Pregled vremena
- Temperatura zraka in tal
- Hitrosti in smer vetra
- Vodna bilanca
- Razlaga spremenljivk
- Opis podatkov

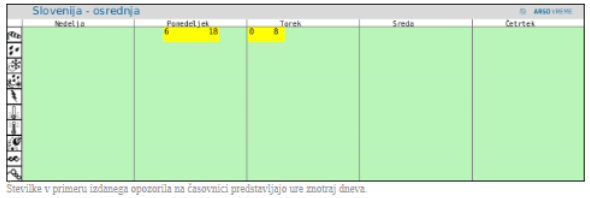
Agrometeorološka napoved

Dnevni regijski agrometeorološki bilten vsebuje poleg splošne vremenske napovedi z opozorili še informacije o meritvah in napovedih meteoroloških spremenljivk (temperatura zraka, padavine, smer in hitrost vetra, trajanje sončnega obsevanja, relativna vlaga v zraku) in agrometeoroloških spremenljivk (temperatura tal, efektivna temperatura zraka, evapotranspiracija, meteoloroška vodna bilanca). Podatki o meritvah so na voljo za do 5 dni nazaj. Napovedi zajemajo večinoma dnevne vrednosti za 1 dan, 3 dni oziroma 10 dni v naprej. V nekaterih primerih so napovedi tudi nekaj-urne.

Pregled vremena

Meritve osvežene: 24.11.2024 11:05 | Napovedi osvežene: 24.11.2024 08:13 | Sončni vzhod: 07:15 | Sončni zahod: 16:22 | Dolžina dneva: 09:07

Časovnica vremenskih opozoril



Številke v primeru izdanega opozorila na časovnici predstavljajo ure znotraj dneva.

Veter	Nizka temperatura
Dež	Visoka temperatura
Nevihte	Požarna ogroženost
Sneg	Obalni dogodek
Poledica/žled	Snežni plazovi

Brez posebnosti | Bodite pozorni | Bodite pripravljeni | Ukrepajte | Več informacij

Ljubljana in okolica - napoved za: nedelja, 24.11.2024

Tmin	-1 °C
Tmaks	8 °C

Vremenska napoved za Slovenijo

Nedelja, 24.11.2024 ob 17h

Ponoči bo na Primorskem in Notranjskem pretežno oblačno, drugod bo precej jasno. Ponekod bo pihal jugozahodni veter. Najnižje jutranje temperature bodo v zatišnih legah severne Slovenije od -5 do -1, drugod od 1 do 7 °C.

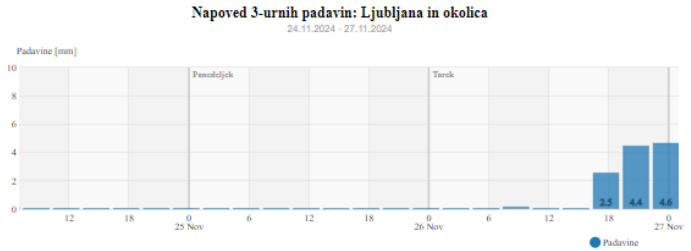
Jutri se bo oblačnost razširila tudi na osrednjo Slovenijo, v hribovitih krajih na zahodu lahko pade kakšna kaplja dežja. Na severu in na

Vodna bilanca

Količina padavin

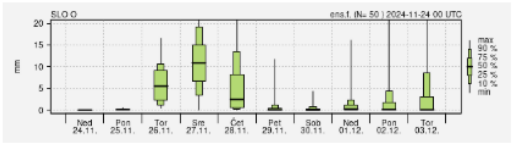
Ljubljana

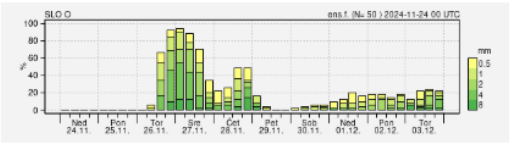
Preteklih 5 dni 19.11.2024 do 23.11.2024 Meritev	35 mm
Nedelja 24.11.2024 Napoved	0 mm
Ponedeljek 25.11.2024 Napoved	0 mm
Prihodnjih 10 dni 24.11.2024 do 03.12.2024	45 mm



Razlaga spremenljivk

Napoved verjetnosti in količine padavin



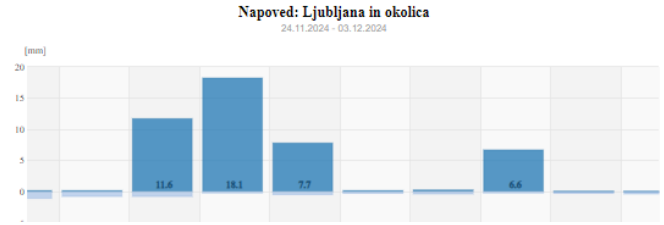


Opis podatkov

Evapotranspiracija

Ljubljana

Preteklih 5 dni 19.11.2024 do 23.11.2024 Meritev	2 mm
Nedelja 24.11.2024 Napoved	1 mm
Ponedeljek 25.11.2024 Napoved	1 mm



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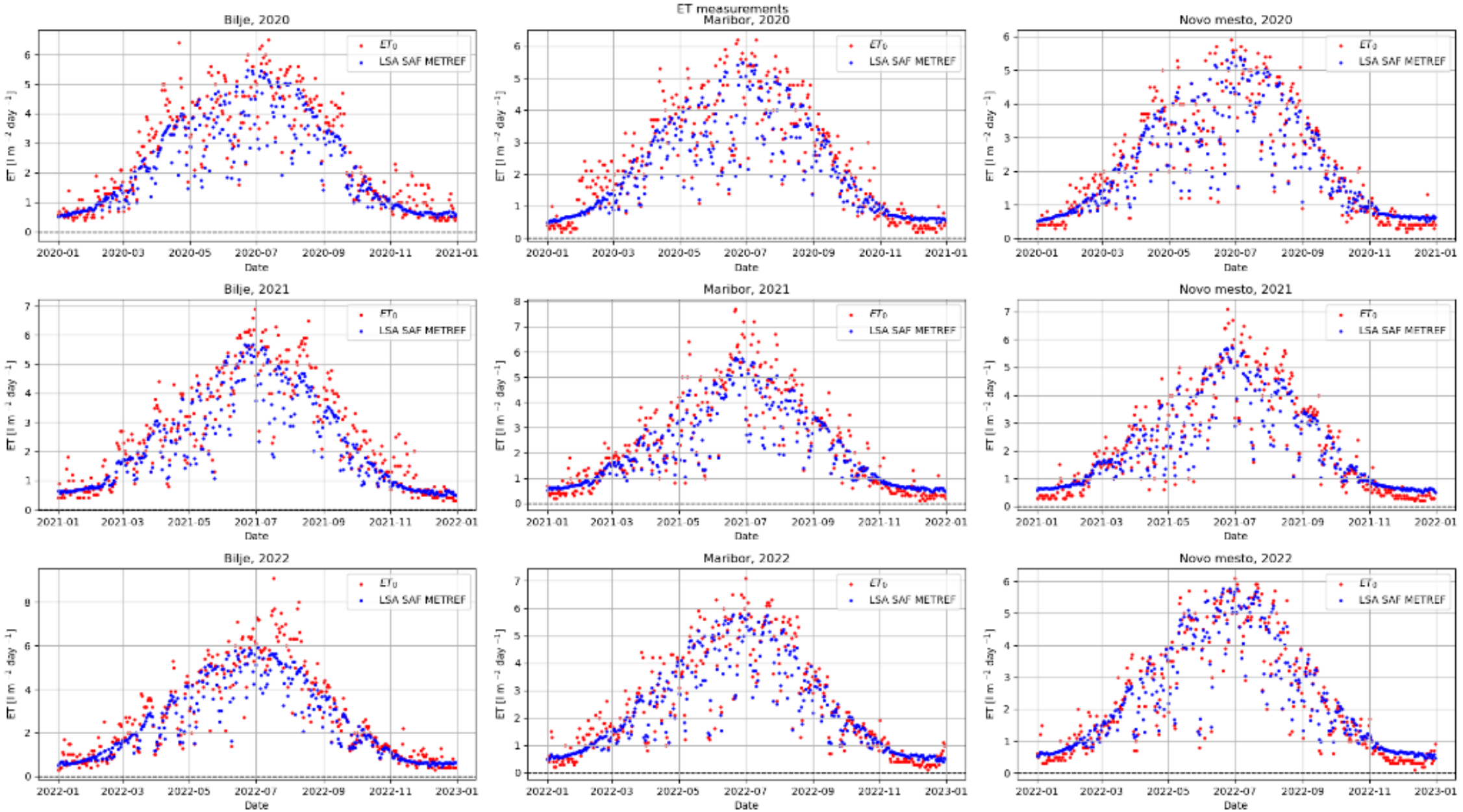
Reference evapotranspiration In-situ vs LSA SAF METREF



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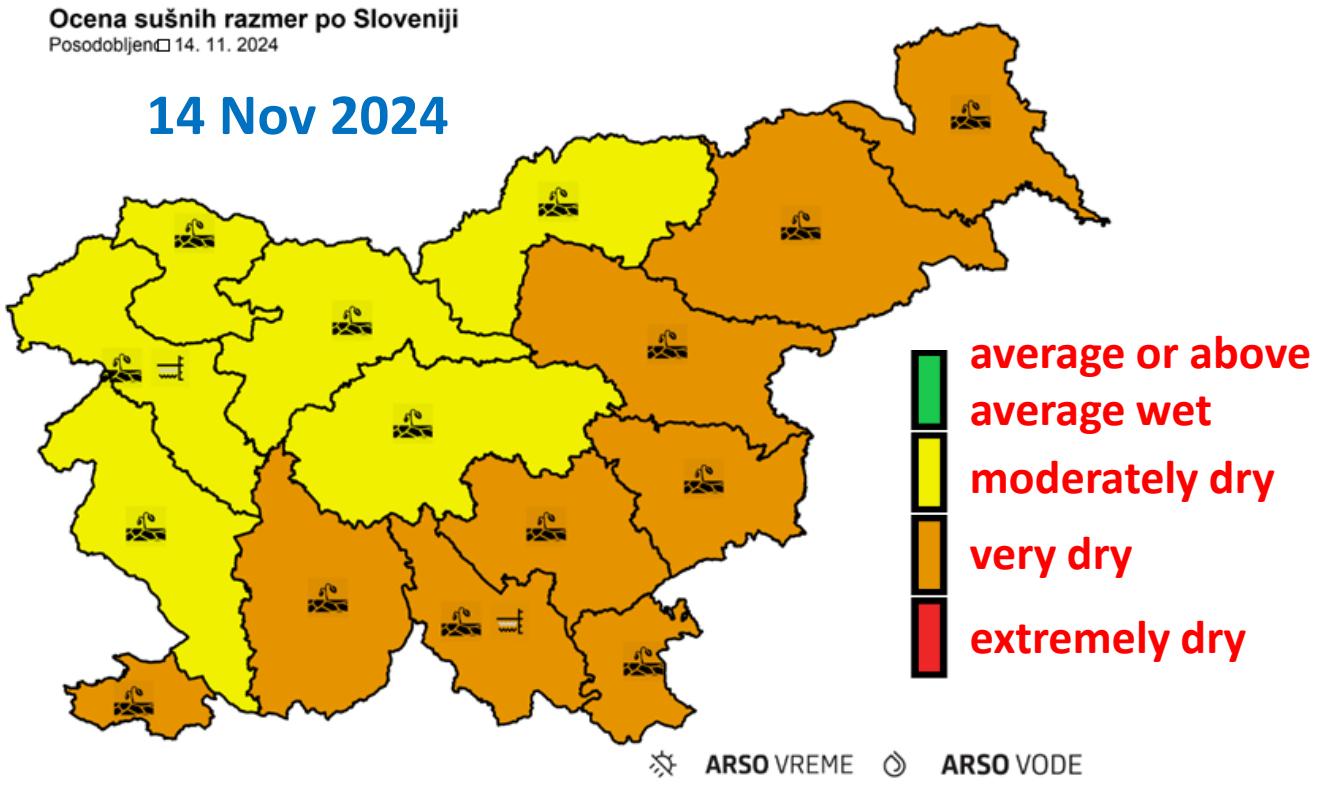
Drought meter

Coloured drought status indicators

Threshold values percentile method calculated over the long-term period for each part of the water cycle.



Weekly bulletin

- Water balance
- Discharge rates of the rivers
- Groundwater
- Meteorological conditions

Agricultural droughts

Hydrological drought of surface waters

Hydrological droughts of groundwater

Jupyter Notebooks

- What are Juypter notebooks?
  - They are interactive documents combining executable code, rich text, equations, and visualisations in a single file.
- The ipynb file extension is used to store these notebooks in a JSON-based format.
- Notebook files run in the server with interactive interpreter in each cell for different programing languges: Python, R, Julia, etc.
- Motivation to use them

See examples

https://gitlab.com/helpdesk.landsaf/lsasaf_data_access/

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Jupyter Notebooks (JNs)

ARSO has prepared a selection of JNs focusing on land surface temperature, vegetation, evapotranspiration and shortwave radiation.

PREREQUISITE
For smooth experience some actions are needed:

- Download the **MLST-ASv2** climatology in `NetCDF4` format from LSA SAF data server.
- Download **MLST-ASv2** data in `NetCDF4` format for the period 1 July 2023 to 31 August 2023 LSA SAF data server in `NetCDF4`.

Plotting the Maximum Daily Temperature Anomaly

About

The aim of this notebook is to produce animated anomalies of daily maximum temperatures at specific geographical region. Additionally, it is meant to show general framework for calculating anomalies with LSA SAF data.

Work is based on the LSA SAF Land Surface Temperature - All Sky version 2 (MLST-ASv2) product which is currently in the demonstration phase, i.e. all the data may be subject to a change.

Daily maximum temperature is determined from multiple daily temperatures. Similarly maximal temperatures could be obtained by using the LSA SAF MLST product. For the period 2004-2022 the climatology is already pre-calculated and publicly accessible.

The focus will be on the heat waves in July and August of 2023 in the Mediterranean region. Temperatures for July 2023 were much higher than their 1991-2020 averages over Southern Europe. Heatwaves were experienced from Spain in the west to the Balkans in the east. In Portugal, France and Italy heatwaves also extended in August. Several temperature records were recorded at the time as described in reference.

Basic Facts on the LSA SAF MLST-ASv2

> **Spatial resolution**: 3km at nadir
>
> **Spatial coverage**: MSG disk
>
> **Time steps**: 30 min
>
> **Data availability**: from 2004

How to access the data

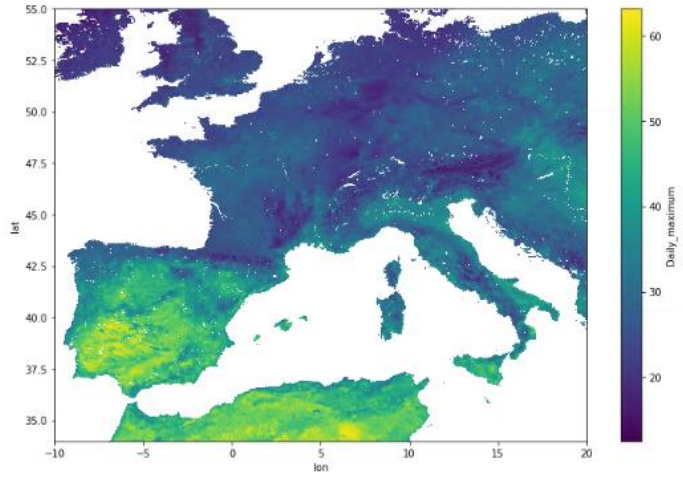
For this example, MLST-ASv2 measurements from 1 July 2023, to 31 August 2023 and MLST-ASv2 Climatology are used. All measurements are available as NetCDF4 file. The LSA SAF products files can be downloaded from the data server available at https://datalsasaf.lsasvcs.ipma.pt/ with prior registration. Data can be downloaded in various ways tutorial, for instance manually, using approach published on lsasaf_data_access GitLab repository or using WebDAV protocol. An additional option is to use the `GNU Wget` program.

Out [3]:

```
<xarray.Dataset>
Dimensions:        (lat: 421, lon: 681)
Coordinates:
  * lat            (lat) float32 55.0 54.95 54.9 54.85 ... 34.15 34.1 34.05 34.0
  * lon            (lon) float32 -10.0 -9.95 -9.9 -9.85 ... 19.9 19.95 20.0
Data variables:
    Daily_maximum  (lat, lon) float32 nan nan nan nan nan ... nan nan nan nan
```

Out [3]:

```
<matplotlib.collections.QuadMesh at 0x7f4d59692a70>
```



2. Calculate the Anomaly Over a `NetCDF4` subset

We calculated the daily maximum. If we repeat this procedure over multiple days, we are able to observe the trends in daily maximum temperature.

To really detect deviations from expected temperature (i.e., climatology), the reference daily maximum temperature needs to be calculated. The daily maximum temperature climatology is already available as a part of the MLST-ASv2 product. The total size of the climatology (calculated from the multi-year data) is about 1.8 GB, therefore it is wise to load only the subset data into the memory.

To calculate anomaly, we compare the measured daily maximum temperature with the 2004-2022 climatology. The entries in the climatology `NetCDF4` file have assigned dates of creation in 2022, therefore we can call them with the list of dates, defined before and use of the `.replace(2022)` command.

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LST Notebooks (*undergoing QA at EUMETSAT*)

- ✓ **Data format and plotting:** Displaying LSA SAF MLST with **cartopy** and **xarray**
- ✓ **Error and quality flag:** Analysing Uncertainty of LSA SAF MLST Product
- ✓ **Comparison to in-situ data:** Comparison Between LSA SAF MLST-ASv2 and Air Temperature Measurements
- ✓ **Visualise anomalies:** Ploting the Maximum Daily Temperature Anomaly

VEGA Notebooks

- ✓ **FVC anomalies:** Calculation of Fractional Vegetation Cover anomaly from LSA SAF ETFVC
- ✓ **Overview of the products:** Demonstration of MSG Based LSA SAF Vegetation Products
- ✓ **Vegetation and fires:** Analyzing Effects of Wildfires on Vegetation Using LSA SAF MDFVC and MSG-FRP Pixel Products

Jupyter Notebooks (JNs)

ARSO has prepared a selection of Jupyter Notebooks focusing on land surface temperature, vegetation, evapotranspiration and shortwave radiation.

ETP Notebooks

- ✓ **Water deficit:** Indicating Water Deficit with the Discrepancy Between Actual and Reference Evapotranspiration
- ✓ **Compare in-situ with satellite:** Comparing LSA SAF METREF Data with Evapotranspiration Estimates Based on In-situ Measurements

DSSF Notebooks

- ✓ **Averaging, quality flags:** Calculating Average MDSSFTD Values in the Different Sky Conditions
- ✓ **Compare in-situ with satellite:** Comparison of MSG Downwelling Surface Shortwave Flux – Total and Diffuse with In-Situ Measurements

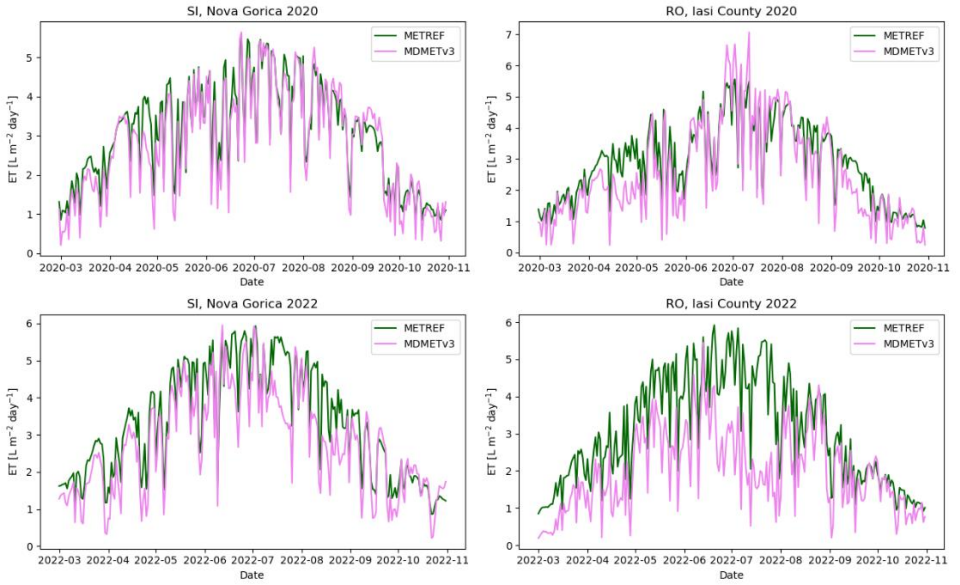
Evapotranspiration JNs

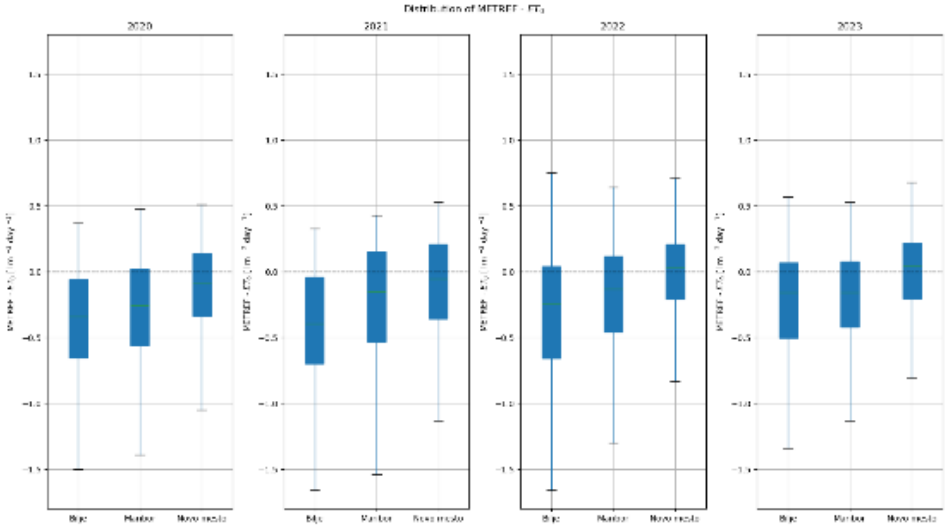
Indicating water deficit

- obtaining the data
- plotting
- indicating water deficit (discrepancy between actual and reference ETP)

Comparing in-situ with satellite data

- comparing LSA SAF METREF data with evapotranspiration estimates based on in-situ measurements





JNs – lessons learnt

- Open source and a large environment that is constantly evolving.
- A sizable community and a lot of resources.
- Some learning curve to prepare JNs and learn how to use them properly.
- Cells do not need to be run procedurally – that might result in bad coding practices and error-prone results when in-memory values are incorrect (best practice to run procedurally!).
- An excellent learning source – anyone with little coding and domain knowledge can experiment in safe environment with nice markdown rendered instruction.


Thank you for your attention!
bostjan.muri@gov.si