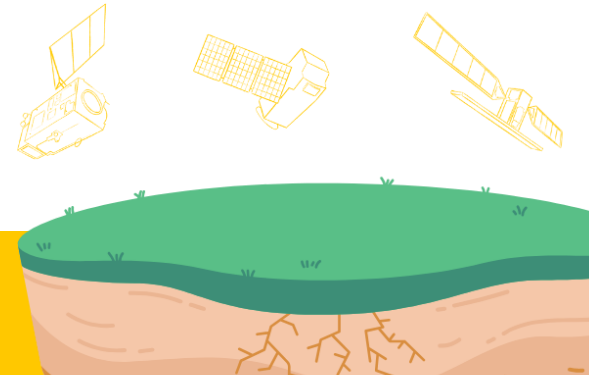
Land monitoring products for agriculture

A use case for the deployment of COALA products for low impact agriculture on the WEkEO EU Copernicus DIAS



A bit about myself and my research

Dr Francesco Vuolo

Senior scientist

Universität für Bodenkultur Wien

- ✓ **Optical data** (e.g. Sentinel-2)
- ✓ **Land Cover & Use** classification methods
- ✓ **Bio-geophysical variable** retrieval methods
- ✓ Methods for **pre-operational provision of satellite-based products** for precision farming

Major milestones

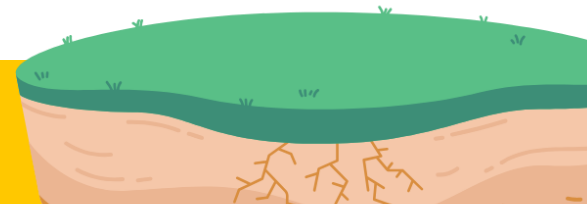
Copernicus Sentinel-2 Level 2-A

2016: On-demand atmospheric correction & higher-level products for land monitoring

2018: S2 Smoothing and gap-filling

2020: Collection of algorithms and tools for vegetation monitoring

2023: Implementation, testing and validation completed. Pre-operational



Links between BOKU, EODC and WEKEO

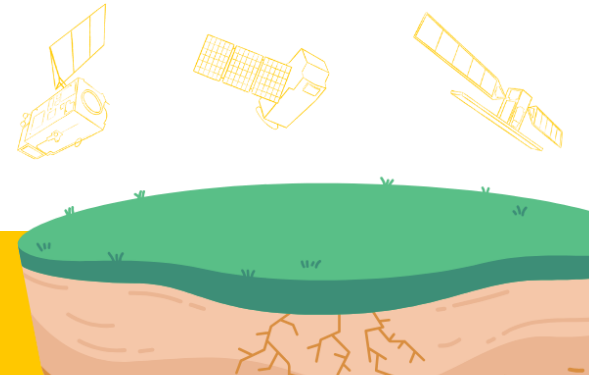
Principal cooperation partner

Federation partner
Copernicus S1 and S2
Long term archive

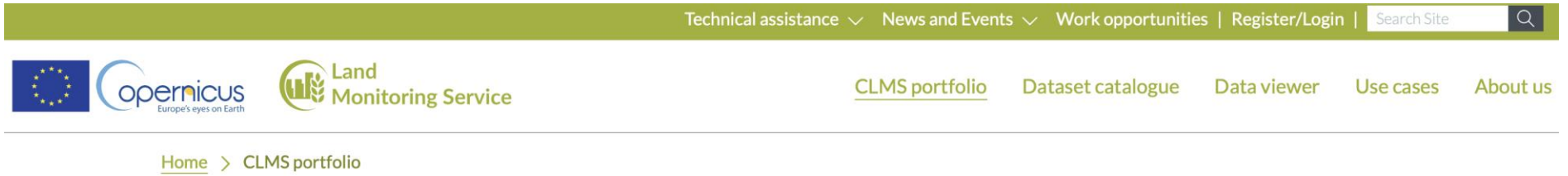
EU Copernicus DIAS

COALA
Copernicus for sustainable Agriculture in Australia

EU Research and Innovation project completed in 2023



Copernicus monitoring products



CLMS portfolio

Land Cover and Land Use Mapping

Land cover classifications complemented by detailed layers on vegetated and non-vegetated land cover characteristics

Priority Area Monitoring

Tailored land cover and land use information with a higher level of detail for specific areas of interest prone to environmental changes

Bio-geophysical Parameters

Qualified bio-geophysical products on the status and evolution of the land surface complemented by the long term time series

Ground Motion Monitoring

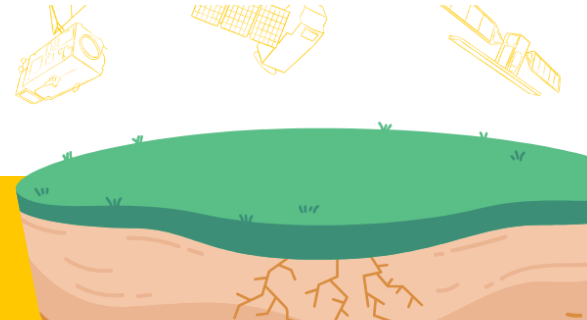
Information on the natural and anthropogenic ground motion throughout Europe with millimeter accuracy

Satellite Data

Satellite image mosaics from Copernicus and commercial satellite missions monitoring land surface conditions

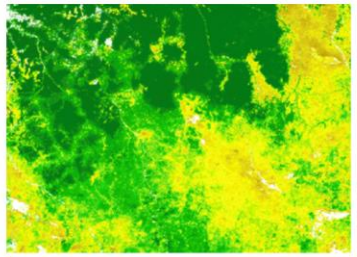
Reference and Validation Data

Ground-based observations, geospatial reference data used in CLMS product creation or validation



Copernicus monitoring products

Vegetation



View in the data viewer

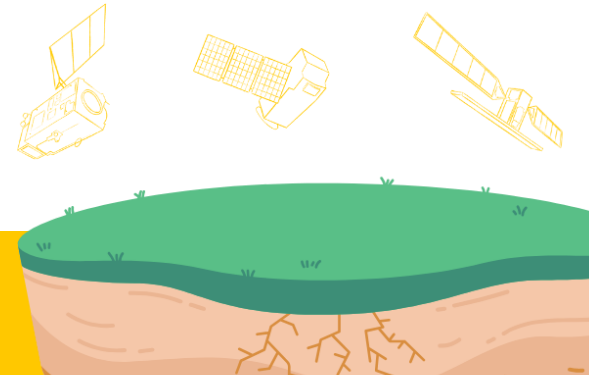
- Main
- Applications & Use cases
- News
- User outreach
- Roadmap

Whether forest, grassland, shrublands, or agricultural areas, it is safe to say that most of the European continent is covered by vegetation. Plants, just like all other living things, experience cycles of growth and decay which vary both within and in between years. These cycles are affected by environmental conditions such as temperature fluctuations, precipitation levels, wildfires, and human disturbances—factors that are becoming less predictable and more extreme in the modern era of climate change and human urbanization.

The Vegetation product group offers a collection of datasets designed to provide analysis of vegetation status across the globe. It boasts a broad range of datasets—including phenology and productivity parameters (e.g., Start of Growing Season, End of Growing Season, Annual Productivity), seasonal growth trajectories (e.g., Plant Phenology Index), Vegetation Indices (e.g., Leaf Area Index, Fraction of Absorbed Photosynthetically Active Radiation, Normalized Difference Vegetation Index, and Plant Phenology Index), and assessments of the outcome of wildfires (e.g., Burnt Areas)—which support users in applications such as Common Agricultural Policy reporting to urban planning at the regional scale or climate change mitigation at the continental scale. The high-resolution phenology data will also allow for a much more detailed assessment of vegetation responses to disturbances like droughts, storms, wildfires, insect infestations, and human influence.

Technical summary

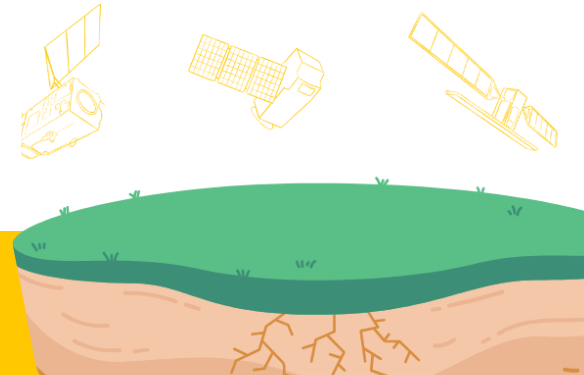
Datasets



Copernicus monitoring products

Datasets

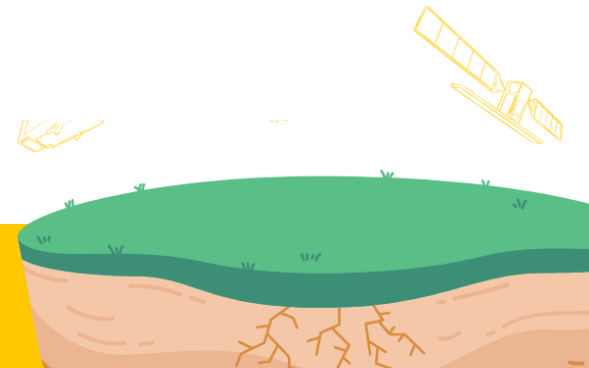
- Burnt Area
- Vegetation Cover
- Vegetation Indices
- Vegetation Seasonal Trajectories
- Vegetation Phenology and Productivity Parameters



Copernicus monitoring products

Leaf Area Index

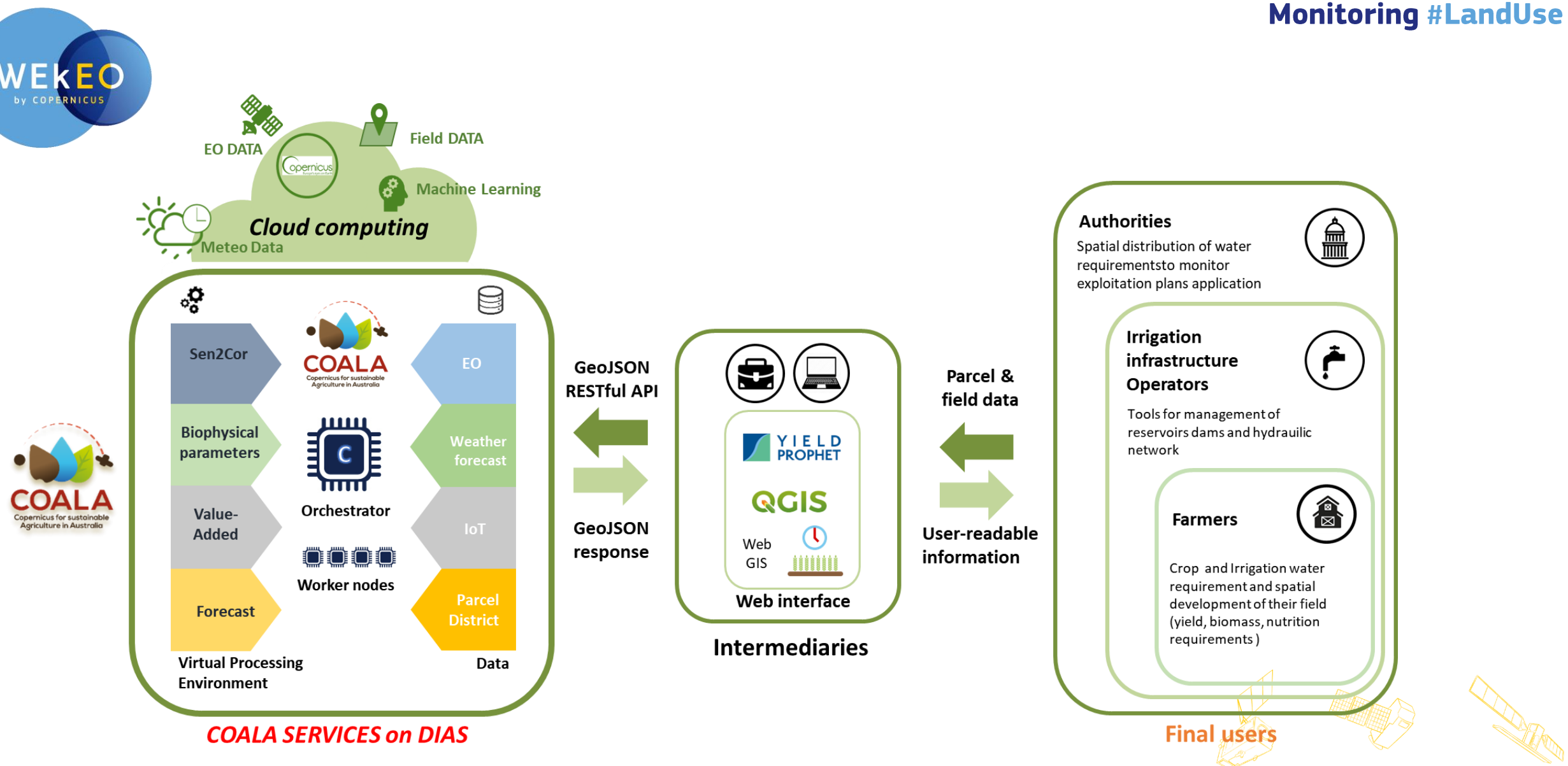
AVAIL.	GEOGR. COVERAGE	TEMP. RESOL.	SPATIAL RESOL.	EO DATA SOURCES
2016 - present	Europe	Daily	10 m	Sentinel-2
1999 - 2020	Global	10-daily	1 km	SPOT/VEGET PROBA-V
2014 - present	Global	10-daily	300 m	Sentinel-3/OLCI, PROBA-V



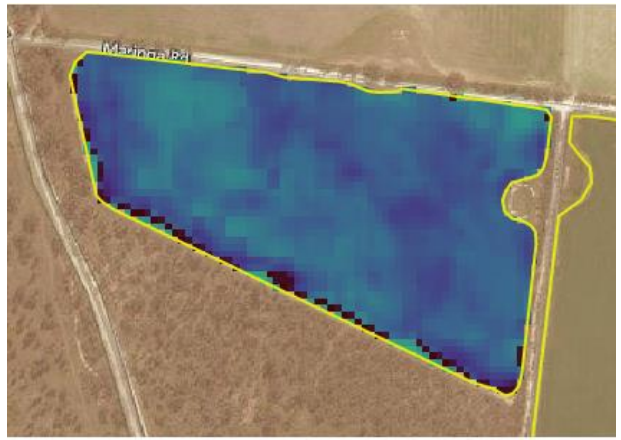
COALA monitoring products for agriculture

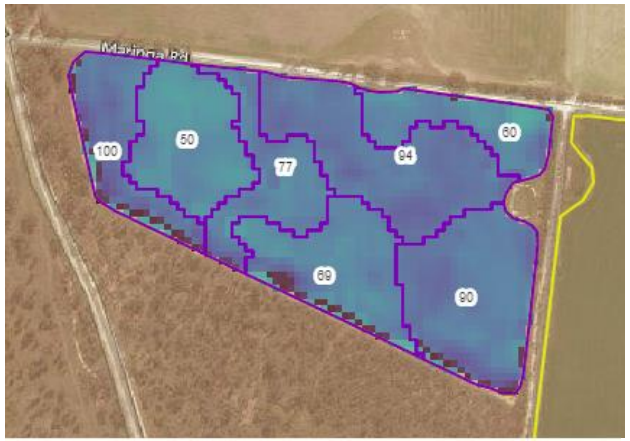
Services	
COALA Integrated Fertilization Service	RS-based Crop Monitoring Reports
	Management Zone Map
	Nitrogen Nutrition Index Map
	Crop Yield Forecast and Estimation Maps
COALA Irrigation Service	Crop Evapotranspiration maps
	Crop Water Requirement (CWR) maps
	Soil Canopy Water Status Map
COALA Integrated Water Management Serv.	Crop Evapotranspiration maps
	Crop type map
	Irrigated area maps

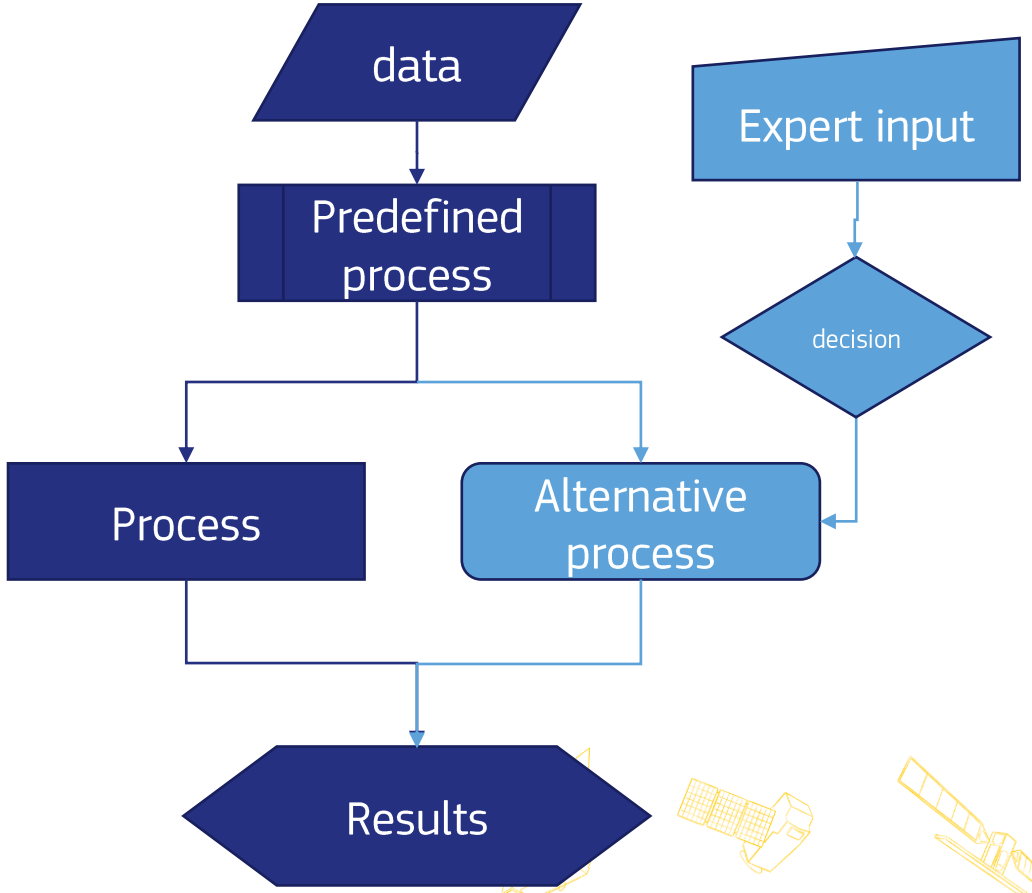
Core data products
Crop Evapotranspiration maps
Crop Water Requirement (CWR) maps
Soil and Canopy Water Status (SCWS)
Irrigated area maps
Management Zone Map (MZM)
Nitrogen Nutrition Index map
Variable Rate Fertilisation map
Crop yield forecast & estimation maps
Crop type map
RS-based Crop Monitoring Report
Other Products


EO DATA
Field DATA
Machine Learning
Cloud computing
Meteo Data
Sen2Cor
Biophysical parameters
Value-Added
Forecast
COALA
Copernicus for sustainable Agriculture in Australia
Orchestrator
Worker nodes
EO
Weather forecast
IoT
Parcel District
Virtual Processing Environment
Data
COALA SERVICES on DIAS
GeoJSON RESTful API
GeoJSON response
YIELD PROPHET
QGIS
Web GIS
Web interface
Intermediaries
Parcel & field data
User-readable information
Authorities
Spatial distribution of water requirementsto monitor exploitation plans application
Irrigation infrastructure Operators
Tools for management of reservoirs dams and hydrauilic network
Farmers
Crop and Irrigation water requirement and spatial development of their field (yield, biomass, nutrition requirements)
Final users

Example of the Management Zone Map



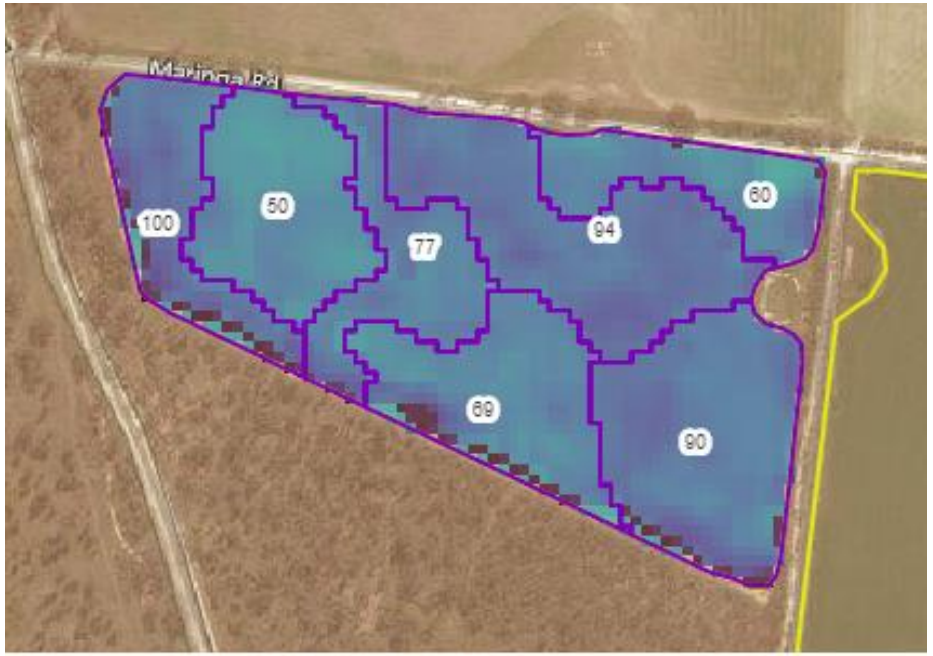


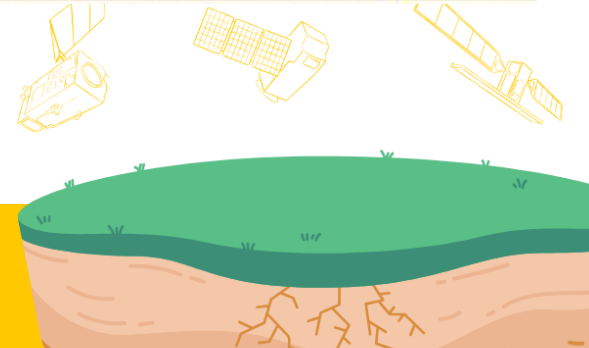


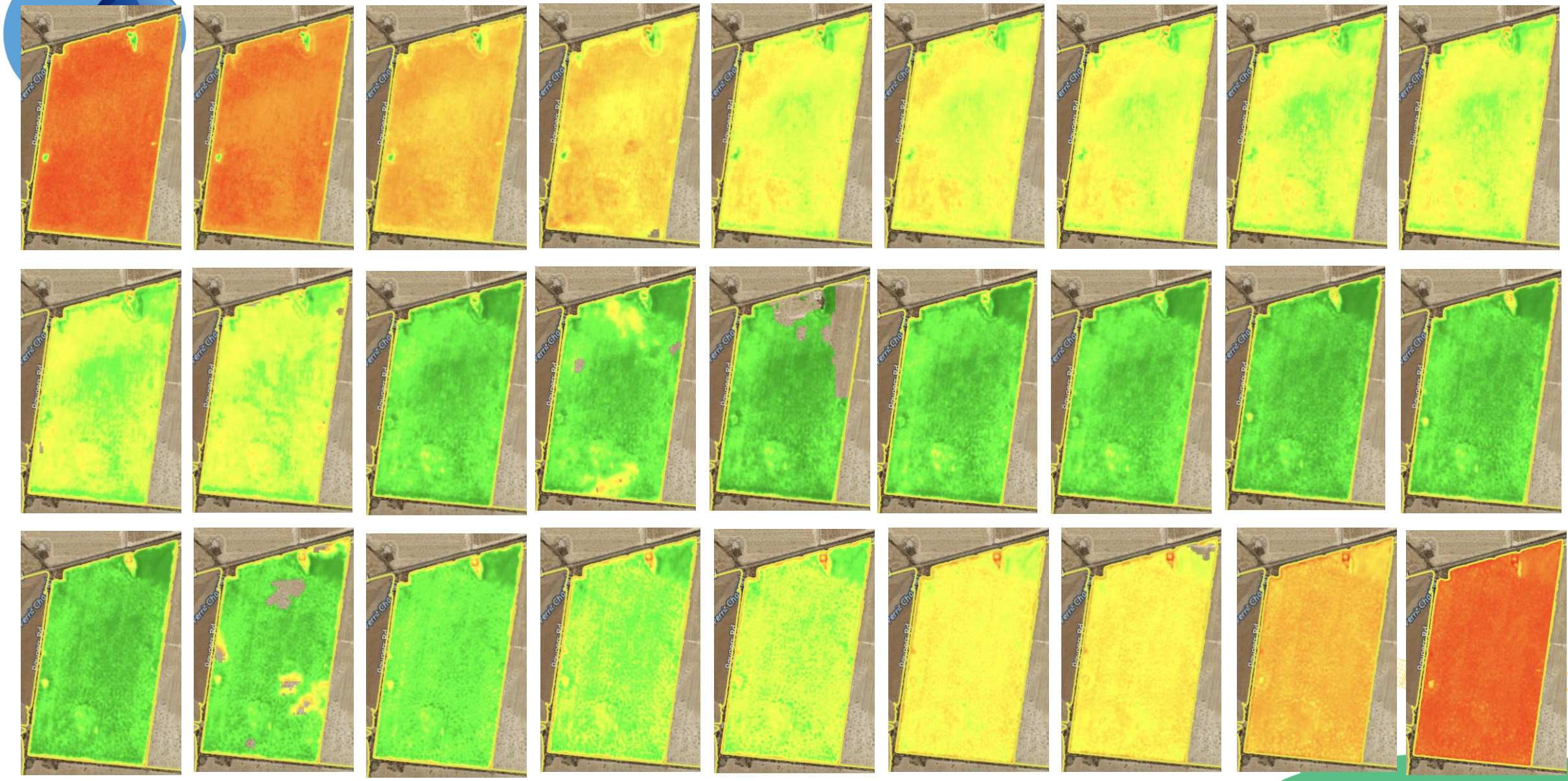
Example of the Management Zone Map

A map that shows the plant growth variability (within-field)

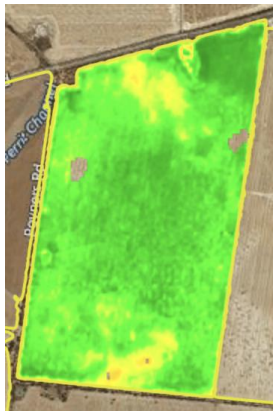
Good for spatial managing of seeding, fertilization and harvesting

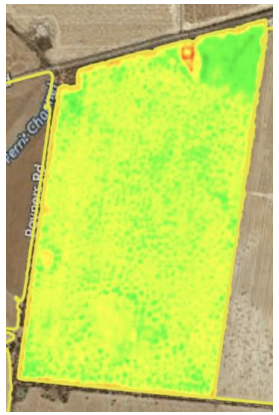
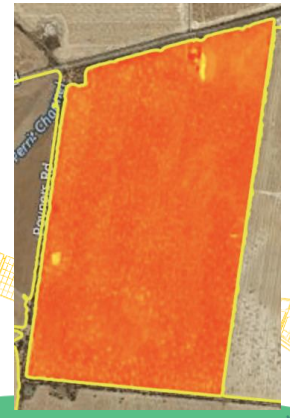




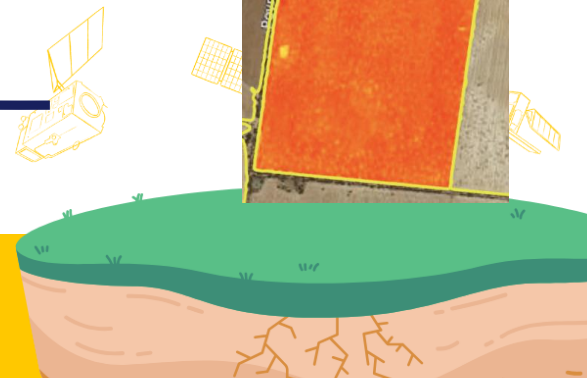




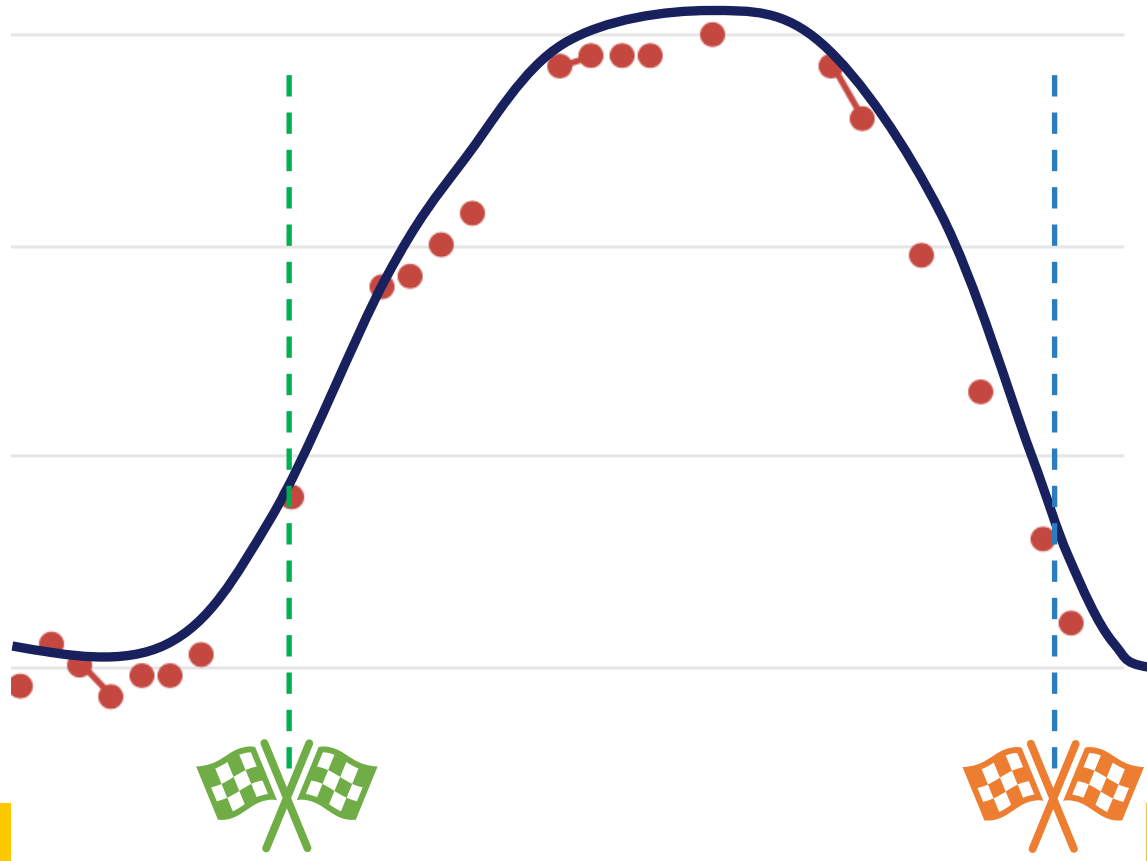


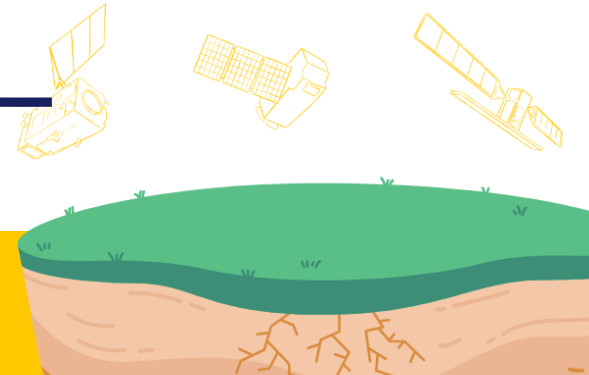



Reconstruct daily data

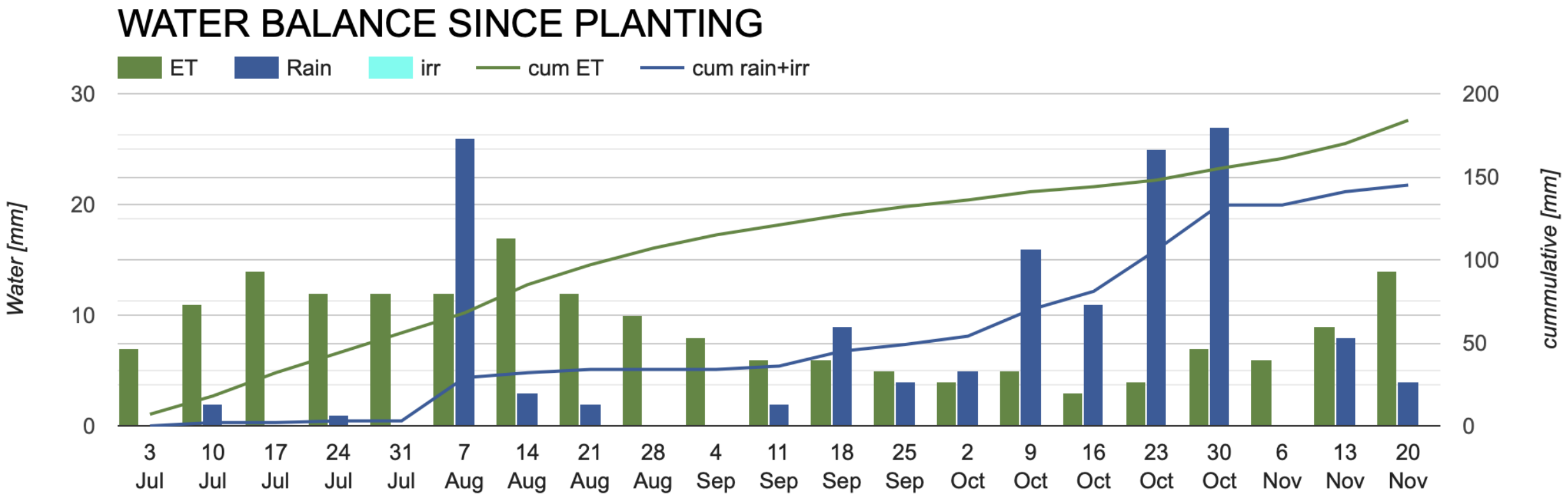


Derive phenological stages

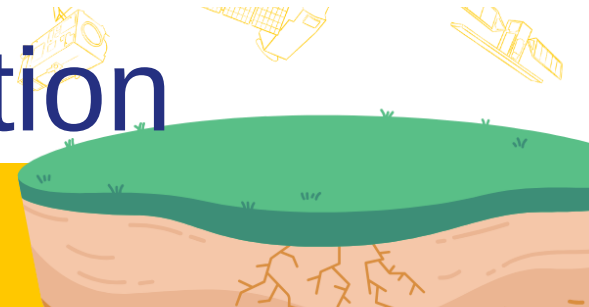




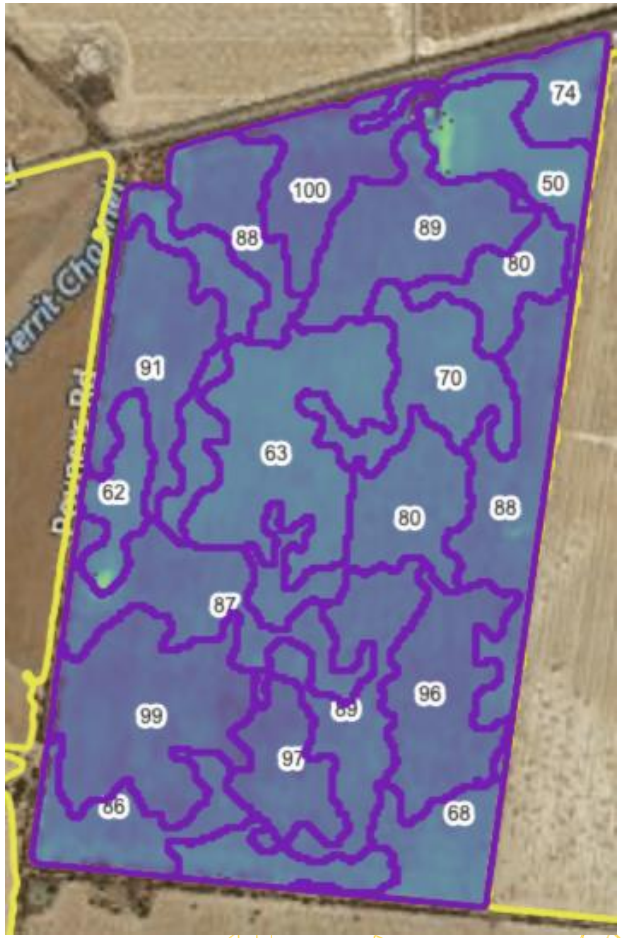
Calculate ET



Total transpiration



Apply segmentation algorithm



Vector data

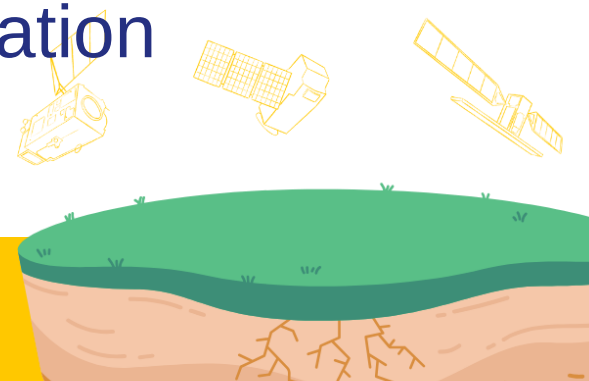
Processes involved

Regular processing

- Atmopheric correction
- Biophysical indicator retrieval
- Cloud masking

On-the-fly Triggered by a request

- L2A and indicators gathering
- Time series data smoothing (daily resolution, per pixel)
- Land surface phenology (start of season, end of seaso
- Daily crop transpiration and accumulation
- Image segmentation



Crop evapotranspiration

https://api.coalaproject.eu/api/indicator/et/rasterData
geometry={ "type": "Point", "coordinates": [16.333500,48.236470] }
srcSrid=4326
&buffer=2000
&date=now
&period=10
&format=image/png
colorMap=1
windMeasureHeight=2
cropHeight=0.5
leafResistance=100
&token=***


```
    "date": "2023-07-13",
    "raster": null,
    "count": 1,
    "sum": 0.8612145781517029,
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    "max": 0.8612145781517029,
    "cover": 1
},
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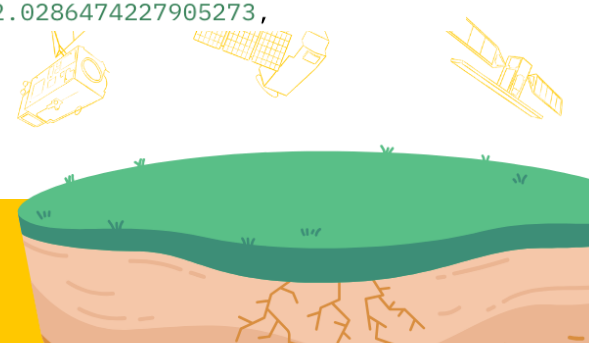
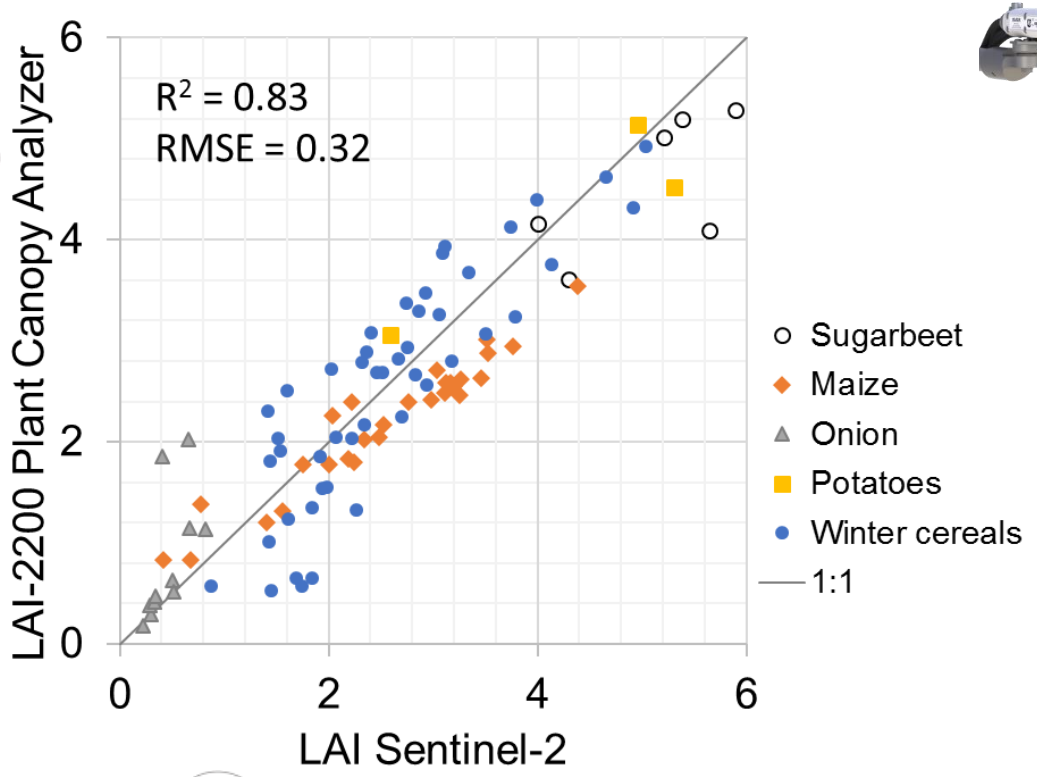
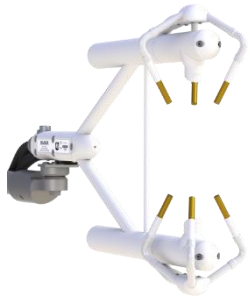


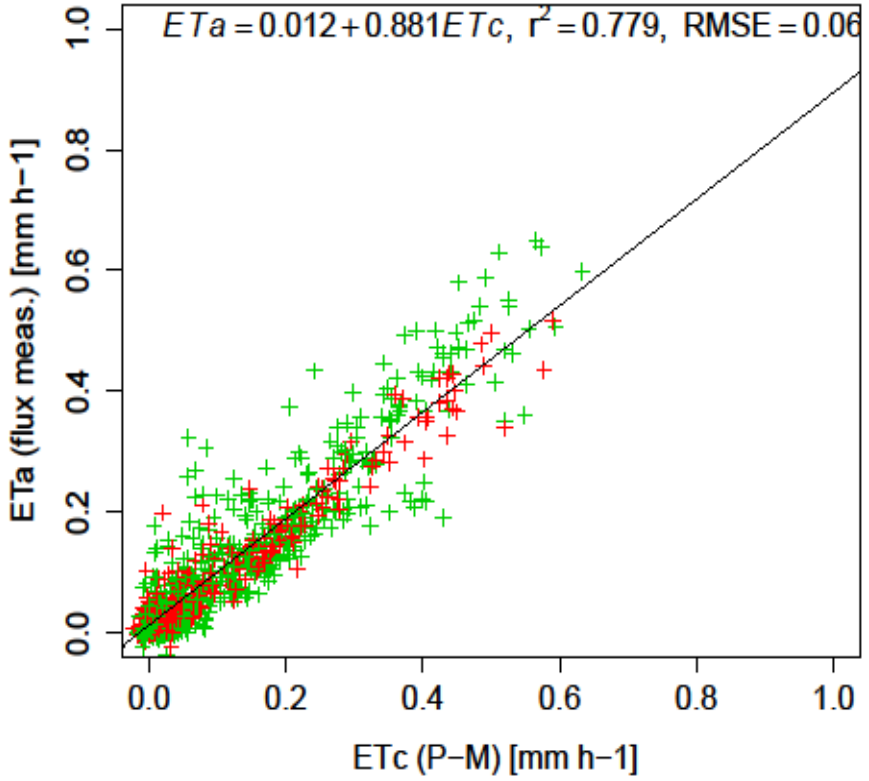
Examples of Validation

Leaf Area Index





Evapotranspiration



sentinel-2

sentinel-2

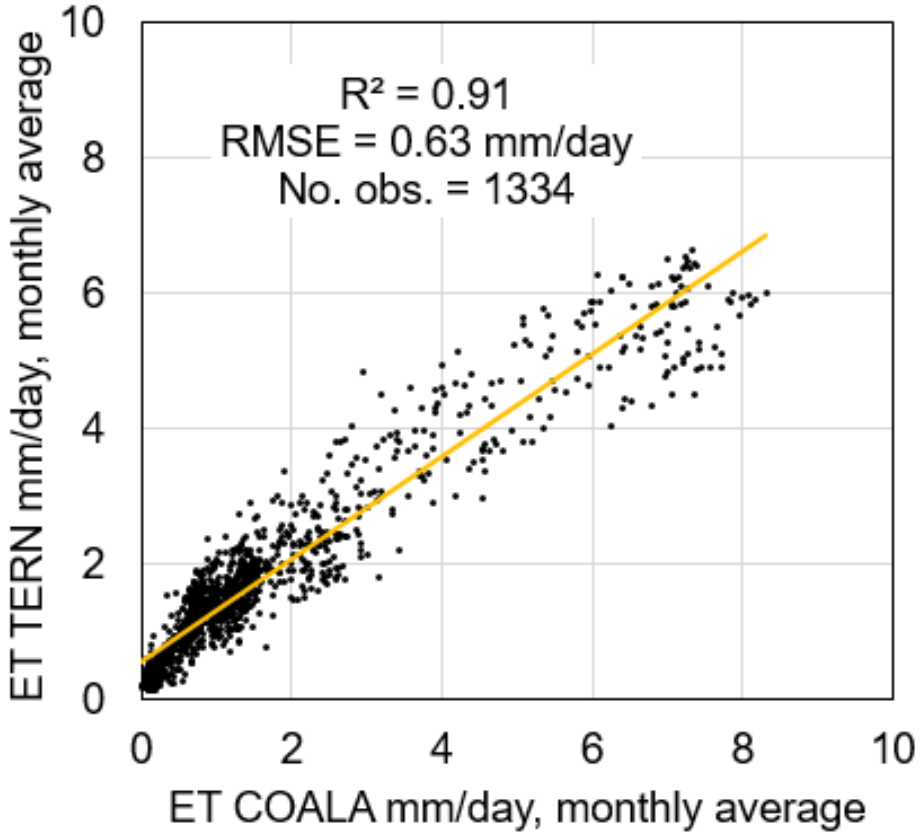
MERCATOR OCEAN INTERNATIONAL

NOVELTIS

COALA vs TERN product

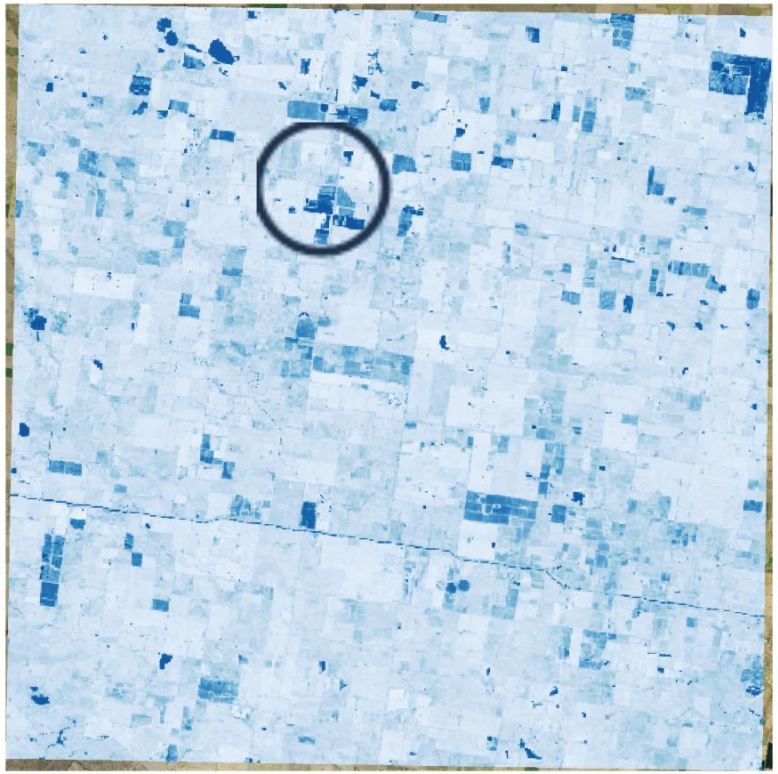
- **Actual evapotranspiration data for the entire Australian continent from TERN**

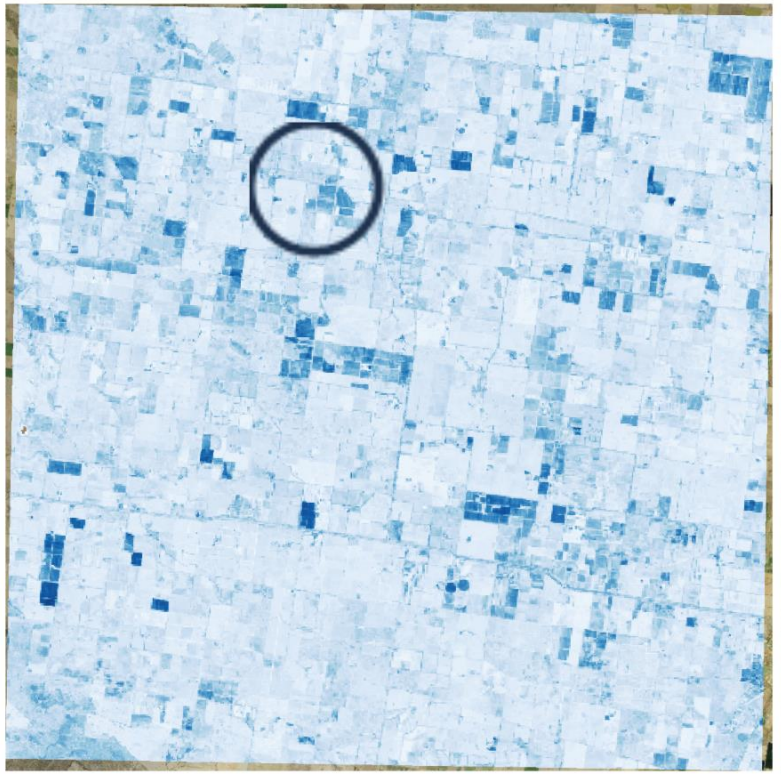
https://www.tern.org.au/news-australia-wide-aet-data/

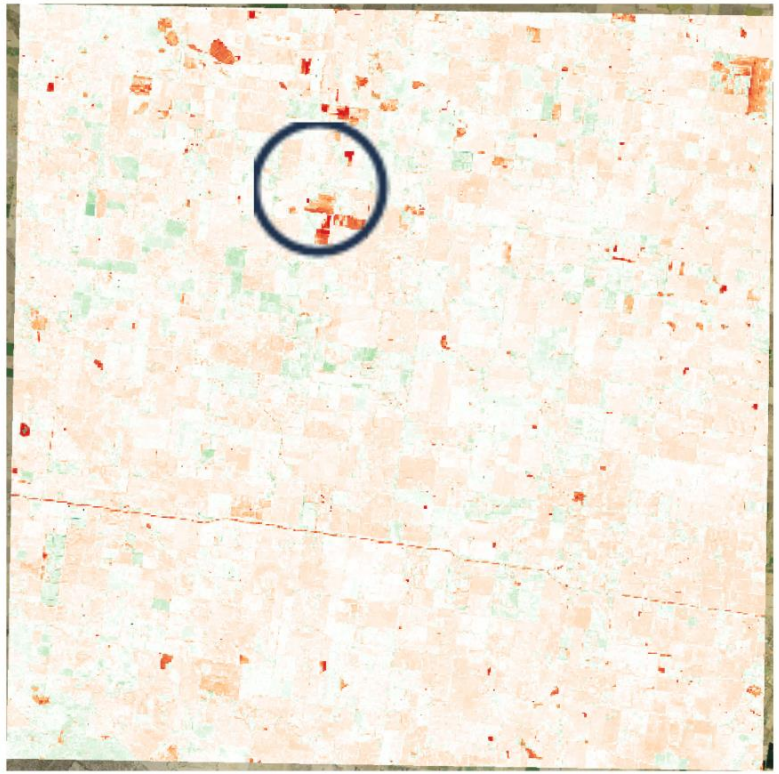


Scatterplot of randomly selected points. Monthly averages from Oct. 2022 to Aug 2023

COALA vs TERN product



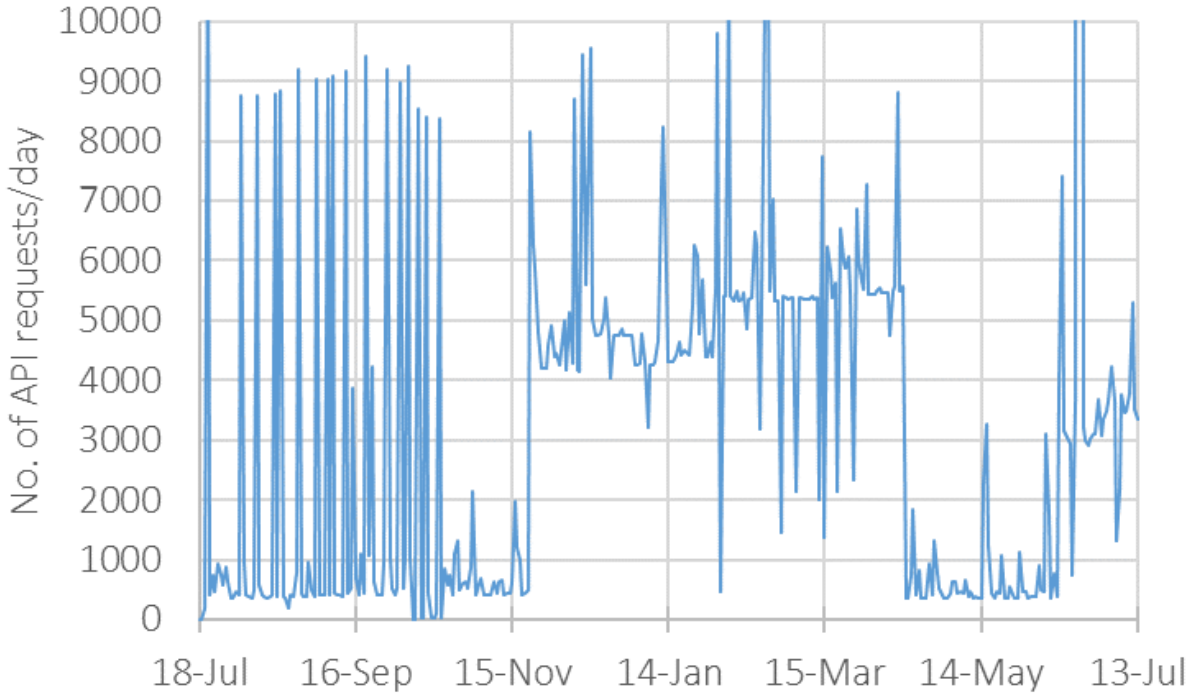




TERN **COALA** **image difference**

Monthly ET Dec 2022

Current deployment

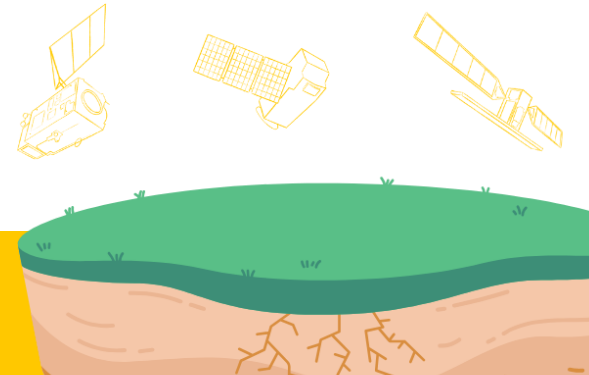


No. of API requests/day.

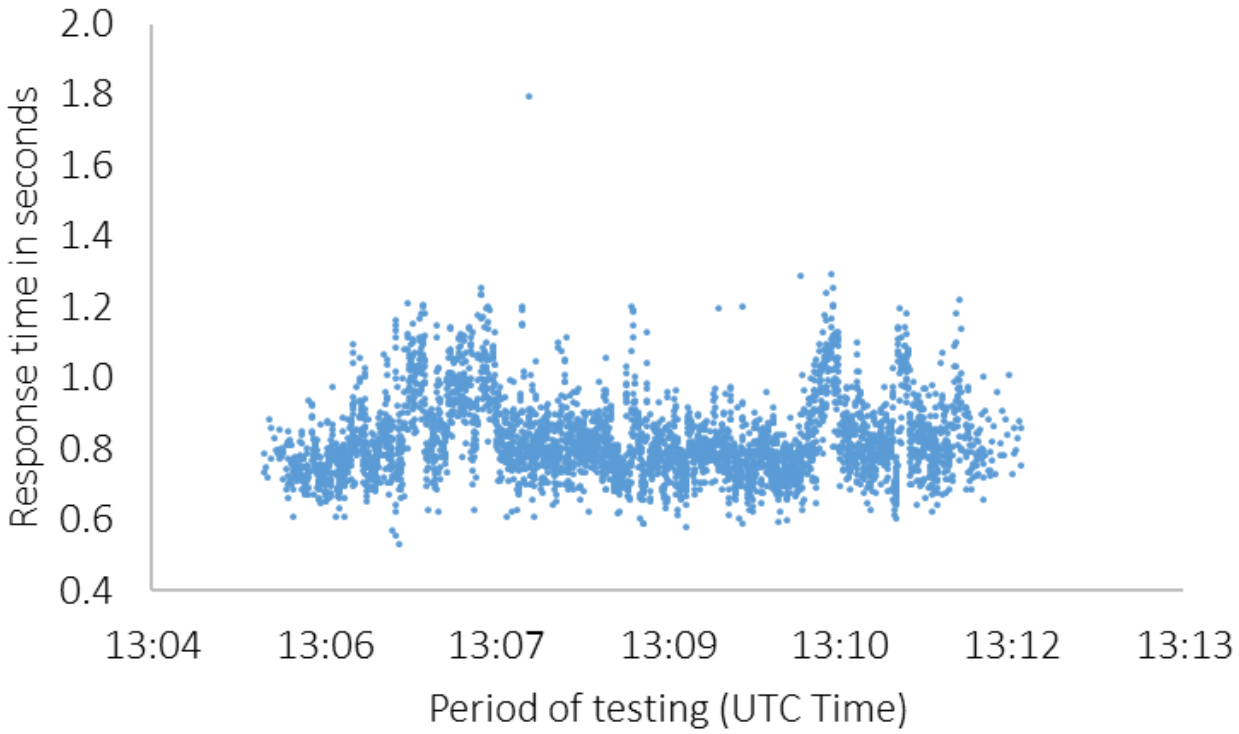
During irrigation time in Australia, COALA received about 5000 requests/day

Activation of various indicators for 114 unique Sentinel-2 granules for a total coverage of about 1 million square kilometres across multiple years, geographic regions, and products (disk space used is 14TB).

The system handles around 5000 API requests per day on average with peaks of about 14000 requests/day.



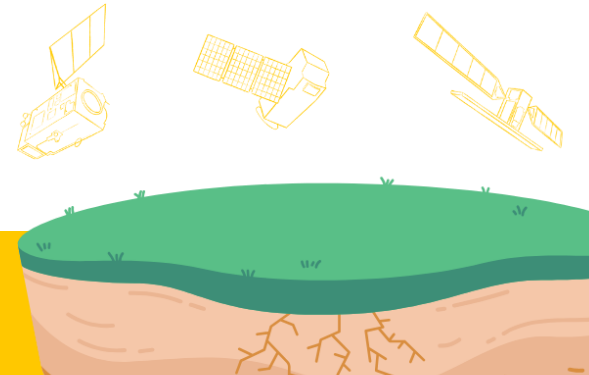
Response time



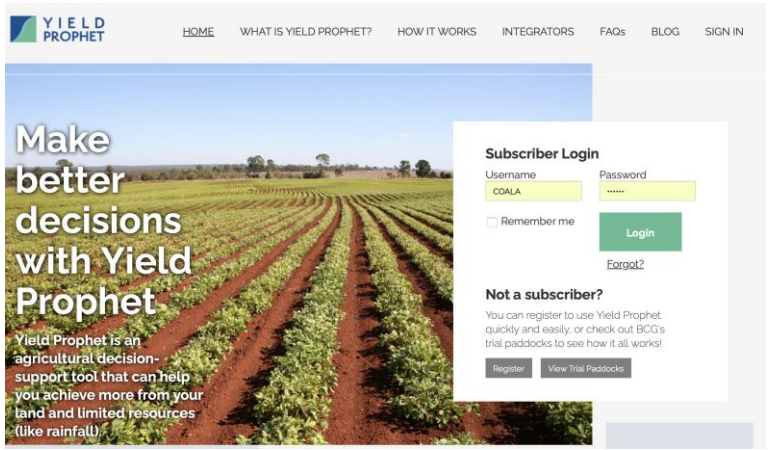
Test of COALA API response time.

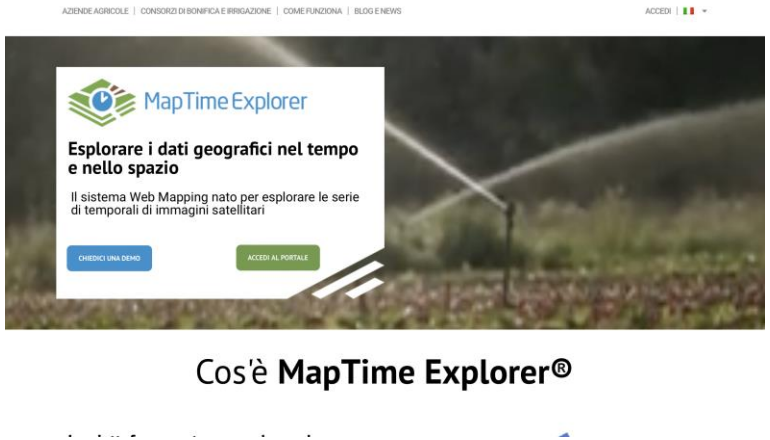
400 repetitions of 10 concurrent queries at unique random locations across the Sentinel-2 granules located in Europe and Australia.

The response time to obtain daily time series (length of 50 days) of ET ranged between 0.6 to 1.2 seconds, with an average time of 0.8 seconds.



Demonstrated integration of products



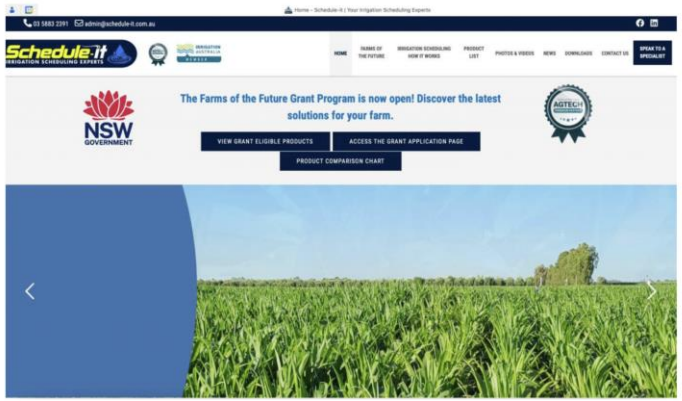


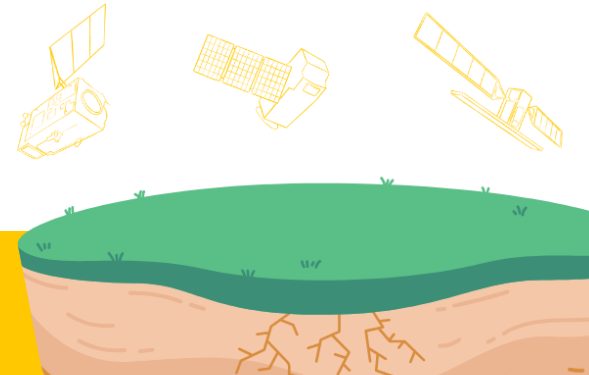
Cos'è **MapTime Explorer®**

COALA indicators for a specific geometry.

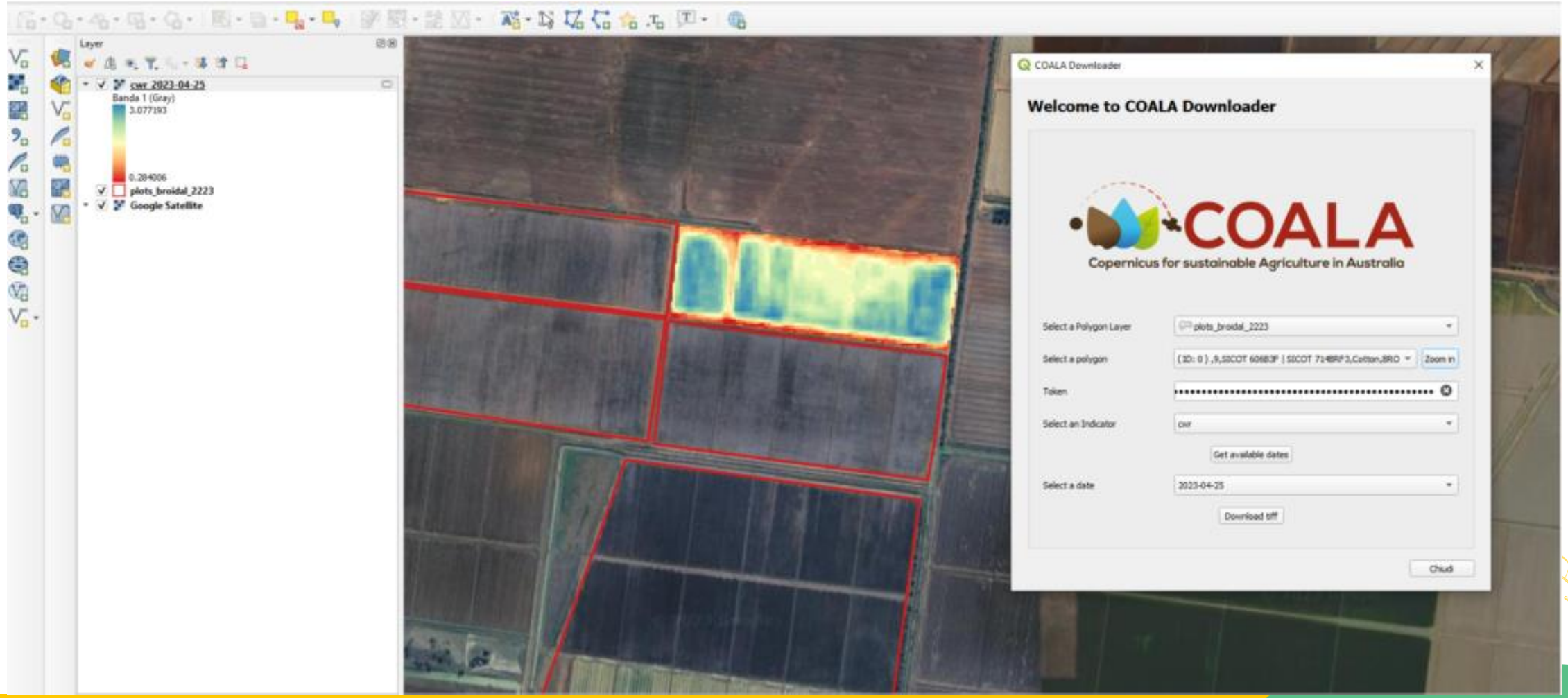
Figure 1.16- Screen capture of the COALA QGIS Plug-in for downloading COALA indicators.

The implementation on the schedule it platform is ongoing and results will be presented at the final meeting and in the final report.





QGIS Plug in


Layer
cwr_2023-04-25
Banda 1 (Gray)
3.077193
0.284006
plots_broidal_2223
Google Satellite
COALA Downloader
Welcome to COALA Downloader
COALA
Copernicus for sustainable Agriculture in Australia
Select a Polygon Layer
plots_broidal_2223
Select a polygon
Zoom in
Token
Select an Indicator
cwr
Get available dates
Select a date
2023-04-25
Download tiff
Chiudi

Unique offer

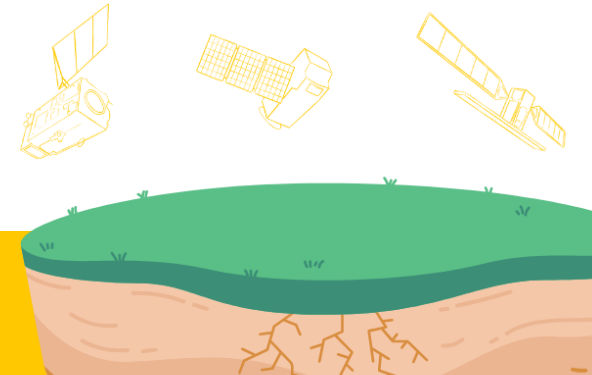
Fast delivery of value-added products while maintaining high quality and accuracy in the derived information.

VALUE

enhanced efficiency, accuracy, scalability, customization, and cost savings

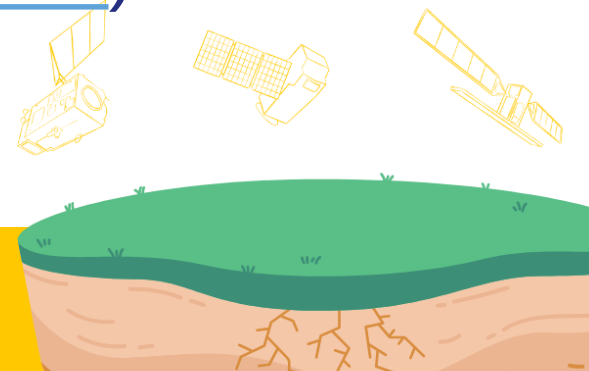
COALA
Copernicus for sustainable Agriculture in Australia

COALA has received funding from Horizon 2020 European Program - H2020-SPACE-2018-2020/DT-SPACE-06-EO-2019/ Type of action: RIA - under the Grant Agreement No 870518



Roadmap

The COALA enabling platform is operational and available in Australia and Europe on a project-by-project basis under a defined service level agreement for commercial and research exploitation.
Links to documentation, examples of use and a token for testing (on pre-defined geographical areas) are provided at the Horizon EU COALA project website (www.coalaproject.eu)



Thank you for your attention!