

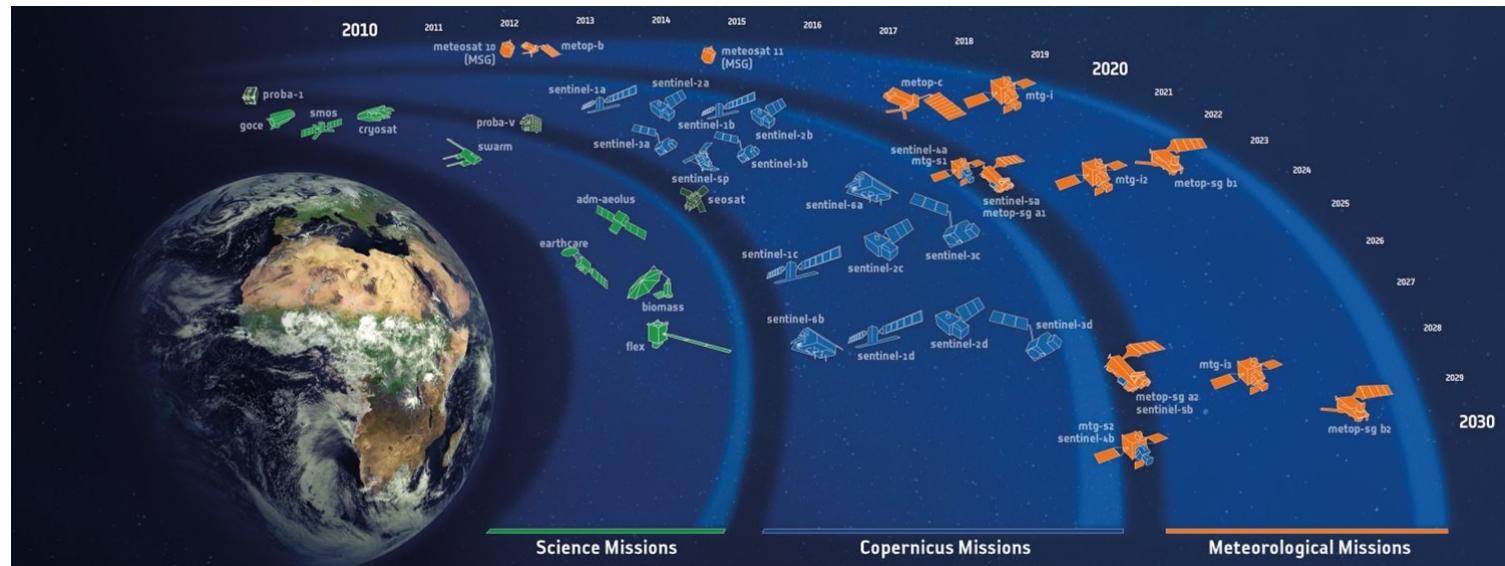
Remote Sensing Data – The European Copernicus Programme

Training course for IAEA

Dr. Matthias Schramm

Earth Observation in Europe

- Earth observation is a rapidly developing technology field
- In the civil domain Europe has taken over leadership



Copernicus Programme



Copernicus Sentinels Missions

Sentinel-1: Radar



A 3 Apr 2014

B 25 Apr 2016

C
2022

D
> 2024

- All-weather, day-and-night radar imaging satellite for land and ocean services
- Frequency: 5.405 GHz
- Polarisation: VV+VH or HH+HV
- **Interferometric Wide Swath**
 - Resolution 20m
 - Repeat Coverage: 3-12 days
- Continuity of ENVISAT



Sentinel-1,
Vienna / Austria,
15.3.2015

Copernicus Sentinels Missions

Sentinel-2: High
Resolution Optical



A 23 Jun 2015

B 6 Mar 2017

C
2022

D
> 2025

- Medium resolution multispectral optical satellite for observation of land, vegetation and water
- Continuity of Landsat, SPOT
- 13 spectral bands with 10, 20 or 60m resolution
- Repeat Coverage: 5 days

Copernicus Sentinels Missions

Sentinel-3: Medium
Resolution Optical &
Altimetry



A 16 Feb 2016

B 25 Apr 2018

C
2023

D
> 2025

Two sensors

- OLCI: sea-surface topography at 300m resolution
 - Continuity of ENVISAT's MERIS
 - 21 spectral bands
- SLSRT: Sea & Land Surface Temperature at 1km resolution
 - Accuracy better than 0.3K for SST

Copernicus Sentinels Missions

Sentinel-4: Atmospheric Chemistry (GEO)



A
2021

B
2027

- Hourly updated atmospheric composition monitoring, pollution
 - Geometric resolution: 8km

Copernicus Sentinels Missions

Sentinel-5P:
Atmospheric Chemistry
(LEO)



A 13 Oct 2017

- Atmospheric composition monitoring
 - Including ozone, nitrogen dioxide, sulphur dioxide
 - Avoids data gap between retirement of ENVISAT and launch of Sentinel-5

Copernicus Sentinels Missions

Sentinel-5: Atmospheric Chemistry (LEO)



A
2021

B
2027

C
> 2027

- Atmospheric composition monitoring
 - Air quality, solar radiation, stratospheric ozone, climate monitoring

Copernicus Sentinels Missions

Sentinel-6: Altimetry



- Altimetry reference mission
 - Changes in sea surface height
 - Global mapping every 10 days

A
2020

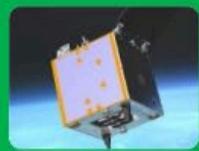
B
2025

Copernicus Contributing Missions



Optical High & Very High Resolution

DMC



Pléiades



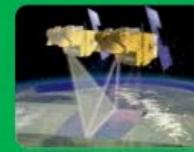
RapidEye



Deimos-2



SPOT (HRS)

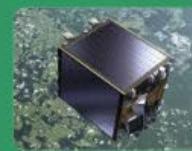


Optical Medium & Low Resolution

SPOT



PROBA-V



and many more ...

Synthetic Aperture Radar

Cosmo SkyMed



Radarsat



TerraSAR-X
Tandem-X



Altimetry

Cryosat



Jason



Atmosphere

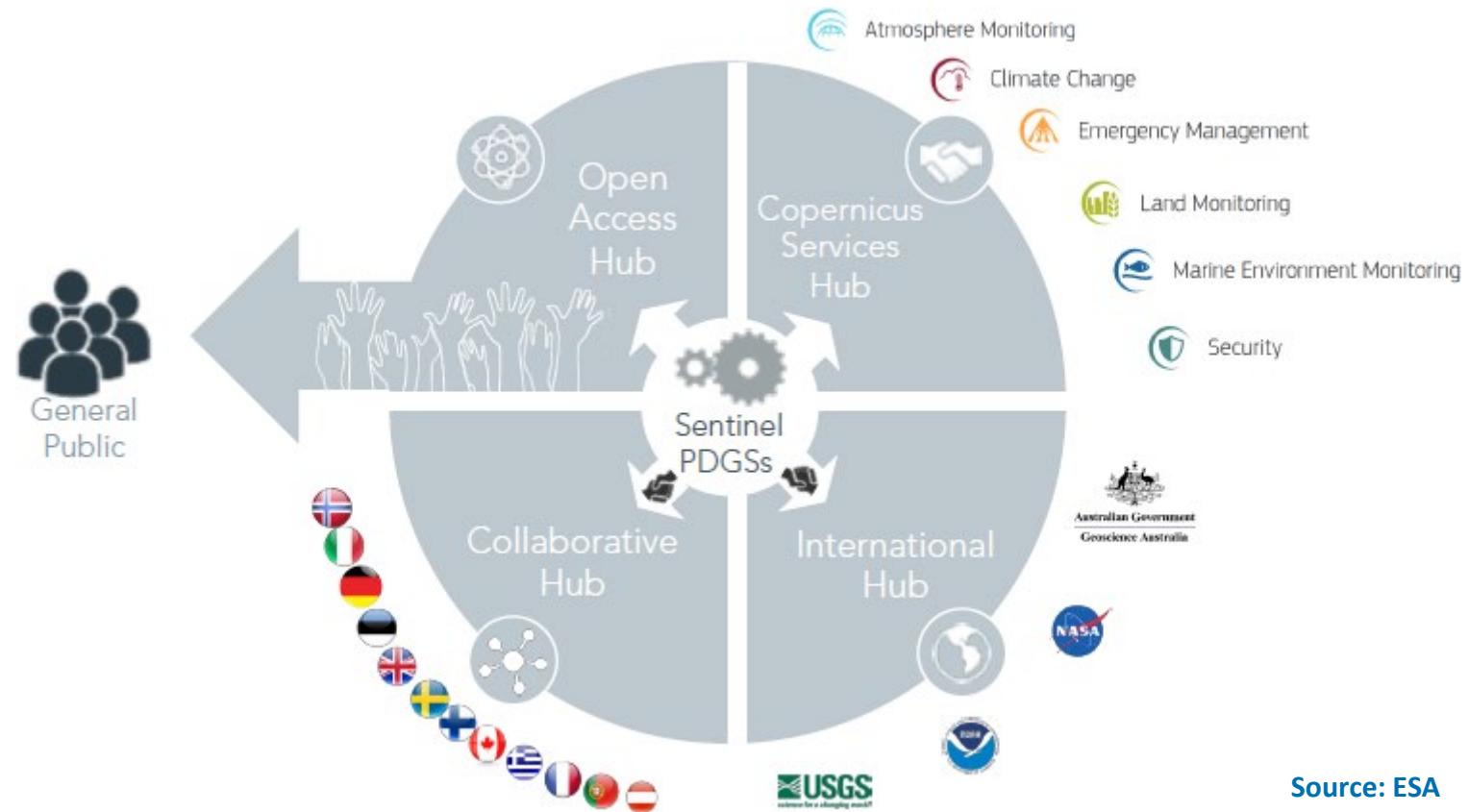
MetOp



MSG



Copernicus Services: Data Hubs



Open Access Hub

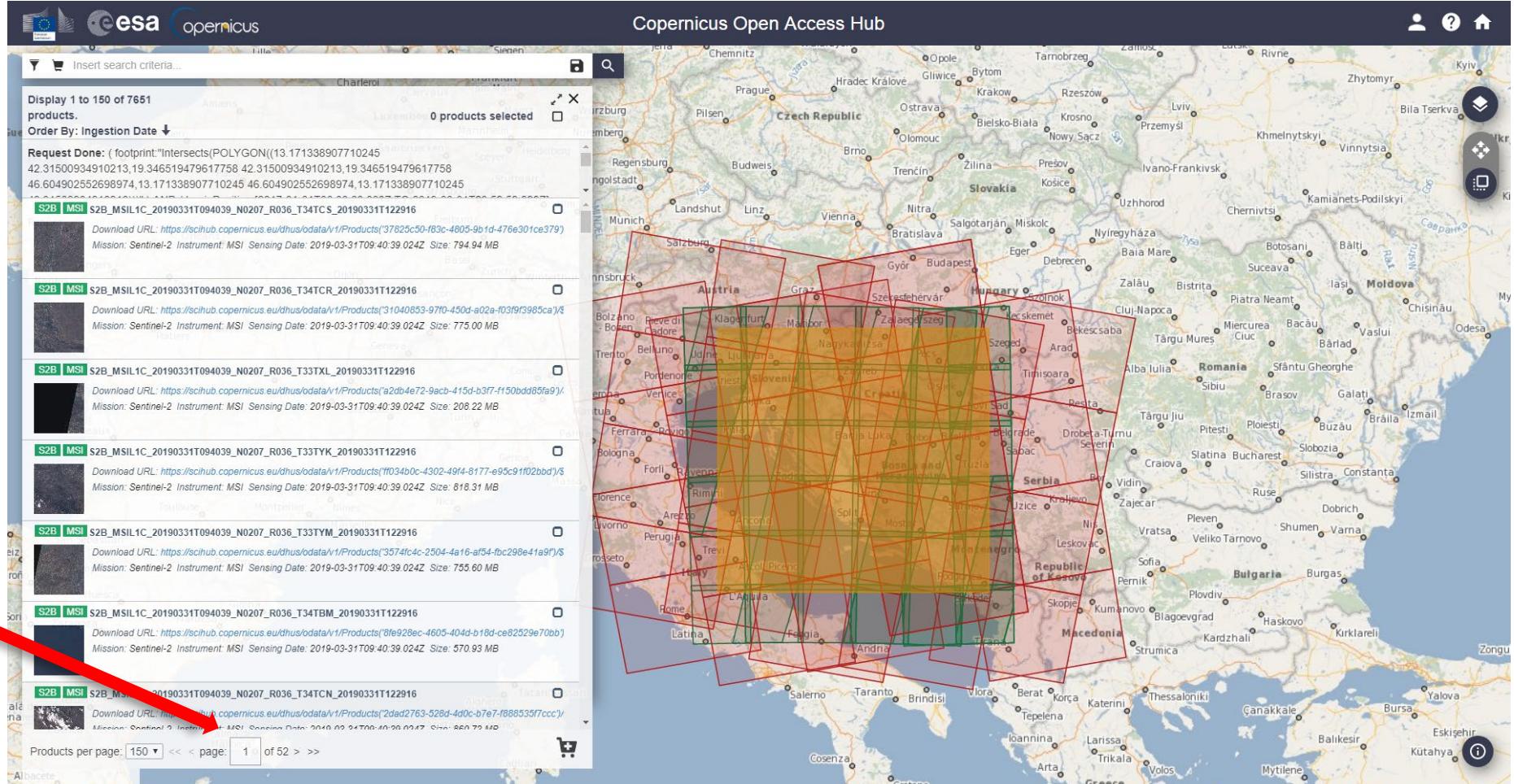
[https://scihub.
copernicus.eu/](https://scihub.copernicus.eu/)

The screenshot shows the Copernicus Open Access Hub interface. On the left, there is a search form titled "Advanced Search" with various filters for Sentinel-1, Sentinel-2, and Sentinel-3 data. The map on the right shows Europe with a yellow shaded area covering the Balkan Peninsula and parts of Italy and Austria. The map includes labels for countries like Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Romania, Bulgaria, and Greece, along with numerous city names.

Open Access Hub

[https://scihub.
copernicus.eu/](https://scihub.copernicus.eu/)

Only maps
layers, which
are listed on
this page



Copernicus Service Hubs



Copernicus Open
Access Hub

<https://scihub.copernicus.eu/>

Collaborative Ground
Segment

Member states mirror sites



EUMETSAT

Copernicus Online
Data Access (CODA)

EUMETCast

<https://eumetcast.com/>



Marine Environment Monitoring
<https://marine.copernicus.eu/>



Security
<https://www.copernicus.eu/en/services/security>



Land Monitoring

<https://land.copernicus.eu/>



Atmosphere Monitoring
<https://atmosphere.copernicus.eu/>



Climate Change

<https://climate.copernicus.eu/>



Emergency Management

<https://emergency.copernicus.eu/>

Copernicus Land Monitoring Service



Copernicus Global Land Service
Providing bio-geophysical products of global land surface

About | Contact us

Copernicus
Europe's eyes on Earth

Home Products Use cases Product Access Viewing Library Get Support



Lake Surf. Water Temp.
Lake Water Quality
Water Bodies
Water Level

Lake Water Quality

Monitoring water quality in lakes and reservoirs is key in maintaining safe water for drinking, bathing, fishing and agriculture and aquaculture activities. Long-term trends and short-term changes are indicators of environmental health and changes in the water catchment area. Directives such as the EU's Water Framework Directive or the US EPA Clean Water Act request information about the ecological status of all lakes larger than 50 ha. Satellite monitoring helps to systematically cover a large number of lakes and reservoirs, reducing needs for monitoring infrastructure (e.g. vessels) and efforts.

The Lake Water Products (lake water quality, lake surface water temperature) provide a semi-continuous observation record for a large number (nominally 1,000) of medium and large-sized lakes, according to the Global Lakes and Wetlands Database (GLWD) or otherwise of specific environmental monitoring interest. Next to the lake surface water temperature that is provided separately, this record consists of three water quality parameters:

1. The turbidity of a lake describes water clarity, or whether sunlight can penetrate deeper parts of the lake. Turbidity often varies seasonally, both with the discharge of rivers and growth of phytoplankton (algae and cyanobacteria).
2. The trophic state index is an indicator of the productivity of a lake in terms of phytoplankton, and indirectly (over longer time scales) reflects the eutrophication status of a water body.
3. Finally, the lake surface reflectances describe the apparent colour of the water body, intended for scientific users interested in further development of algorithms. The reflectance bands can also be used to produce true-colour images by combining the visual wavebands.

LWQ product updates
First Lake Water Quality products
Fri, 25 May 2018
Read more or Subscribe

Lake Water Quality characteristics

LWQ 300m LWQ 1km

Access Algorithm Quality Application Technical Documents Gallery

Product version	Access	Sensor	Temporal coverage	Spatial information	Timeliness
1	Product portal, FTP	ENVISAT MERIS	May 2002 - March 2012	Global, 1/3km	Archive only
1	Product portal, FTP	Sentinel3 OLCI	July 2017 - present	Global, 1/3km	Within 3 days after the end of the synthesis period

- Vegetation, Energy, Water, Cryosphere, Hot Spots, Groundbased
- Product portal:
<https://land.copernicus.vgt.vito.be>

Copernicus Land Monitoring Service



Copernicus Global Land Service
Providing bio-geophysical products of global land surface

Copernicus
Europe's eyes on Earth

Welcome Matthias Schramm
User Delivery space
Data pool
Logout
Help
Profile
FAQ
Contact

Watch our video tutorials

Catalogue search Subscription

Lake Water Quality - LWQ 300m V1 NRT

Help Collection

LWQ 300m V1 NRT
LWQ 300m V1 Offline
LWQ 1km V1 NRT
LWQ 1km V1 Offline

Basic Date
Start date 01/01/2018
End date 31/03/2019
22.7604
1.5955 roi 23.9652
-0.0651

Search Reset

Number of results per page 20

Hosted by VITO

Lake Water Quality

Monitoring water quality in lakes and reservoirs is key for fishing and agriculture and aquaculture activities. Large indicators of environmental health and changes in the Water Framework Directive or the US EPA Clean Water status of all lakes larger than 50 ha. Satellite monitoring of lakes and reservoirs, reducing needs for monitoring info.

The Lake Water Products (lake water quality, lake surface observation record for a large number (nominally 1,000) of the Global Lakes and Wetlands Database (GLWD) or other interest. Next to the lake surface water temperature three water quality parameters:

1. The turbidity of a lake describes water clarity, or whether the lake is turbid. Turbidity often varies seasonally, both with the amount of algae and cyanobacteria.
2. The trophic state index is an indicator of the productivity of a lake. Indirectly (over longer time scales) reflects the eutrophication of a lake.
3. Finally, the lake surface reflectances describe the albedo of a lake. This is used by scientific users interested in further development of methods to produce true-colour images by combining the three water quality parameters.

Lake Water Quality characteristics

LWQ 300m LWQ 1km

Access Algorithm Quality Application Technical

Product version	Access	Sensor	Temporal coverage
1	Product portal, FTP	ENVISAT MERIS	May 2003 – May 2012
1	Product portal, FTP	Sentinel3 OLCI	July 2016 – present

200 km 100 mi

Version 2.2.1-20180225

About us Terms of use Privacy policy Feedback

A screenshot of the Copernicus Global Land Service interface. The main view is a map of West Africa showing lake water quality products. A red rectangular box highlights a specific area in the central part of the continent, likely representing a search or analysis result. The left sidebar provides navigation and information about lake water quality characteristics. The right sidebar shows a catalogue search for 'Lake Water Quality - LWQ 300m V1 NRT' with various search filters and results. The bottom of the interface includes links to 'About us', 'Terms of use', 'Privacy policy', and 'Feedback'.

CORINE Land Cover (CLC)



- <https://land.copernicus.eu/pan-european>

- One of the most well known / used products from Copernicus Land Monitoring Service

- Produced for 1990, 2000, 2006, 2012, 2018

- 44 classes, MMU 25 ha for areal phenomena / 100m linear phenomena



CORINE Land Cover (CLC)



Copernicus Climate Data Store



- <https://cds.climate.copernicus.eu>
- In Beta
- Data (excerpt):
 - Climate projections
 - Seasonal forecasts
 - Satellite observation
 - Glaciers, sea ice, ...
 - Climate indices
 - Reanalysis
 - Historical data

The screenshot shows the homepage of the Copernicus Climate Data Store. At the top, there are logos for the European Commission, Copernicus (Europe's eyes on Earth), ECMWF, and Climate Change Service. A banner at the top right says "This is a new service -- your feedback will help us to improve it" and has a "B E T A" badge. The main heading is "Welcome to the Climate Data Store". Below it, a sub-headline reads "Dive into this wealth of information about the Earth's past, present and future climate." It mentions that it is freely available and functions as a one-stop shop to explore climate data. It encourages users to "Register for free" to obtain access to the CDS and its Toolbox. It also states that the service is constantly improving and adding new datasets. For more information, it points to the catalogue and FAQ. There is a search bar with fields for "Enter search term(s)", "Dataset", and a dropdown menu. Below the search bar are three cards: "Climate Data Store Toolbox" showing a line graph, "Climate Data Store API" showing code snippets, and "Access climate reanalysis (ERAS)" showing a map of Europe with a color scale from -12 to 12.

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Thematic Exploitation Platforms

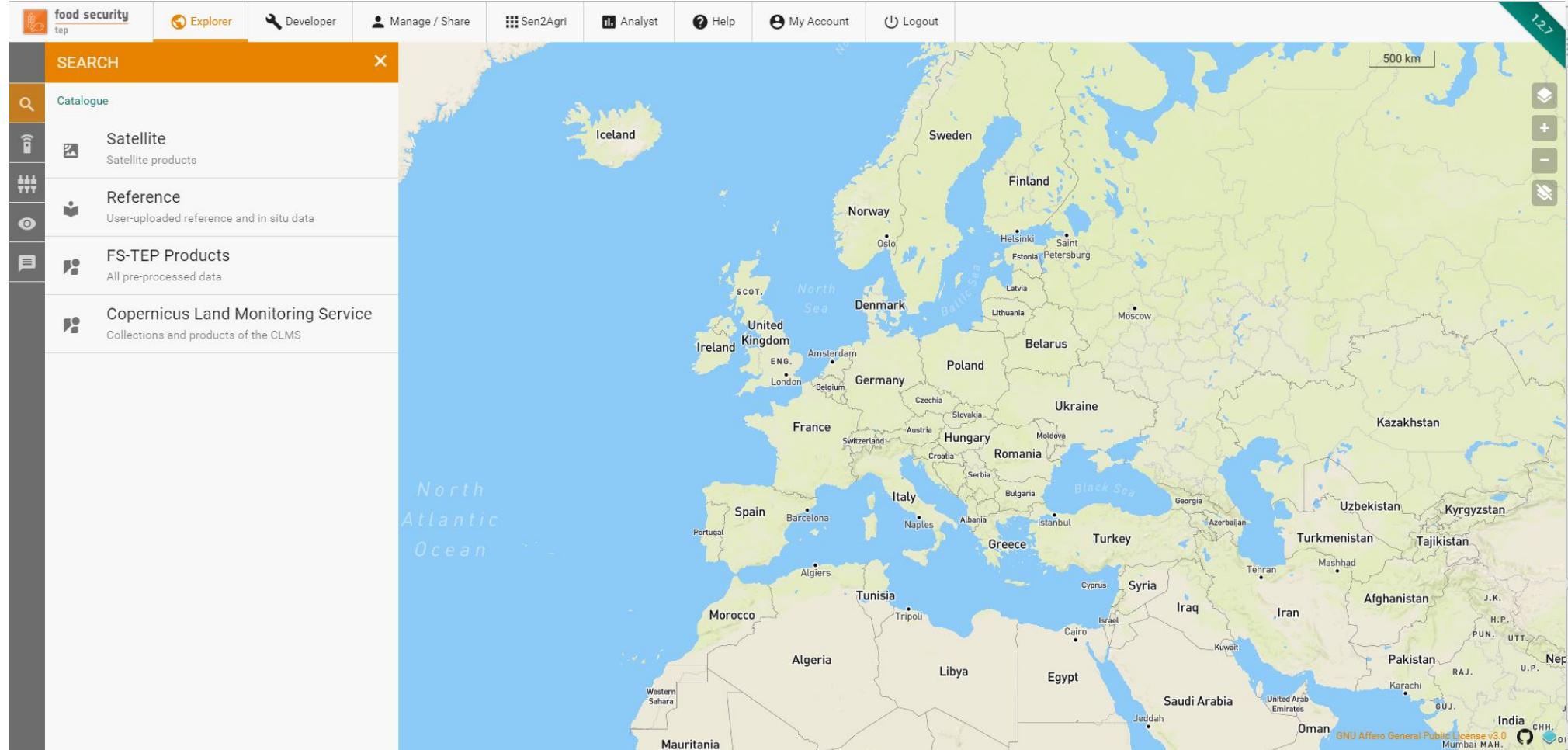
- Funded by ESA
- Access to data and tools / resources to work with them
- More targeted information system
- <https://tep.eo.esa.int/>
- Pre-operational services for users accommodated by ESA
 - Not free of charge





food security

tep





The screenshot shows the food security tep web application interface. At the top, there are navigation links: Explorer, Developer, Manage / Share, Analyst, Help, My Account, and Logout. A search bar is at the top left. The main area features a map of Ireland and the surrounding seas. A red polygon is overlaid on the map, covering parts of County Dublin and surrounding areas. Below the map, a sidebar contains filters for Satellite products (Sentinel-2, L1C), Product date (09-12-2017 to 09-03-2018), and AOI (POLYGON coordinates). The results section displays three sentinel-2 products:

Product ID	Date Range	Size	Cloud Coverage
S2A_MSIL1C_20180202T113311_N0206_R080_T29UPV_20180202T164512.SAFE	Start: 2018-02-02T11:33:11Z End: 2018-02-02T11:33:11Z	0.61 GB	2.89
S2B_MSIL1C_20180108T113439_N0206_R080_T29UPV_20180108T133524.SAFE	Start: 2018-01-08T11:34:39Z End: 2018-01-08T11:34:39Z	0.66 GB	0.08
S2A_MSIL1C_20171227T114501_N0206_R123_T29UPV_20171227T135533.SAFE	Start: 2017-12-27T11:45:01Z End: 2017-12-27T11:45:01Z	0.76 GB	2.08

At the bottom, there are links for GNU Affero General Public License v3.0 and a feedback form.



food security tep | Services

The screenshot shows the food security tep Services interface. On the left, there's a sidebar with a search bar, a 'WORKSPACE' section containing a service named 'S2NDVI' which computes the NDVI index on a Sentinel-2 Image, and a 'Processor running mode' set to 'Standard'. Below that, there's a field for 'The input Sentinel-2 tile *' with the value 'sentinel2:///S2A_MSIL1C_20180225T114351_N0206_R1' and a 'Label' field containing 'Dublin 2018-02-25'. At the bottom of the sidebar is a large orange play button. The main area features a map of Northern Ireland and the United Kingdom with various locations labeled. A modal dialog box is centered over the map, asking 'Confirmation needed' and stating 'This job will cost 1 coin.' with a question 'Are you sure you want to continue?'. There are 'CANCEL' and 'CONFIRM' buttons at the bottom of the dialog. In the background, there's a list of processing results and messages.

Confirmation needed

This job will cost 1 coin.

Are you sure you want to continue?

CANCEL CONFIRM

S2A_MSIL1C_20180225T114351_N0206_R123_T29UPV_20180225T170025.SAFE

Start: 2018-02-25T11:43:51Z End: 2018-02-25T11:43:51Z Size: 0.75 GB Cloud Coverage: 0.73

Product Type: L1C

S2B_MSIL1C_20180220T114339_N0206_R123_T29UPV_20180221T151310.SAFE

Start: 2018-02-20T11:43:39Z End: 2018-02-20T11:43:39Z Size: 0.74 GB Cloud Coverage: 0.23

Product Type: L1C

S2A_MSIL1C_20180215T114351_N0206_R123_T29UPV_20180215T165533.SAFE

Start: 2018-02-15T11:43:51Z End: 2018-02-15T11:43:51Z Size: 0.76 GB Cloud Coverage: 9.88

Product Type: L1C

S2A_MSIL1C_20180202T113311_N0206_R080_T29UPV_20180202T164512.SAFE

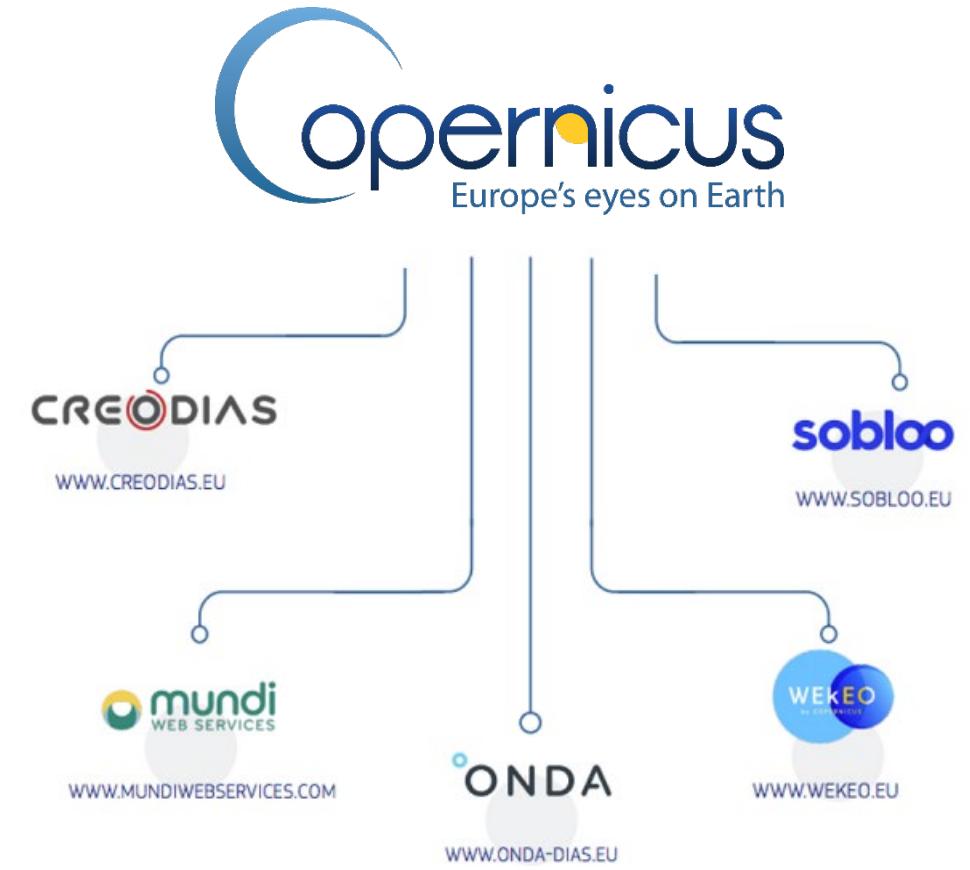
Start: 2018-02-02T11:33:11Z End: 2018-02-02T11:33:11Z Size: 0.61 GB Cloud Coverage: 2.89

Product Type: L1C

S2B_MSIL1C_20180108T113439_N0206_R080_T29UPV_20180108T133524.SAFE

Data and Information Access Services - DIAS

- Facilitating / standardising access to Sentinel data and Copernicus' operational services
- Discovering, manipulating, processing and downloading Copernicus data
- Access to cloud-based tools (open source and/or on a pay-per-use basis).
- Competitive platforms
 - Access to additional commercial satellite / non-space data sets
- Users can develop / host own applications in the cloud



In Situ data

- Copernicus In Situ component
 - <https://insitu.copernicus.eu/>
 - CORDA – Copernicus Reference Data Access (entry point)
 - Currently open to Copernicus service providers
- INSPIRE by European Commission
 - <http://inspire-geoportal.ec.europa.eu>
 - Governmental data
- World Data System of the International Science Council (ISC)
 - <https://www.icsu-wds.org/services/data-portal>
 - PANGAEA data publisher
 - <https://www.pangaea.de/>



Federalisation of Geodata Service Providers

- Big-Data Paradigm „Processes-to-the-data“
- Many EO service providers lead to heterogeneous offer
- openEO: API for standardised communication with service providers
 - Users can use same code (e.g. via Jupyter, web service) on several processing services
- <https://openeo.org/>
- <https://github.com/Open-EO/>



Questions ?

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