Hungarian Space Office

SZENT ISTVÁN UNIVERSITY

esa

→ 7th ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

4–9 September 2017 | Szent István University | Gödöllő, Hungary

SENTINEL DATA ACCESS & PROCESSING TOOLS

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with contribution from **ESA-ESRIN**

Presentation Overview

- Copernicus Sentinel Missions
- Historical Missions Data Access
- Sentinel Data Access
- Sentinel Application Platform | SNAP
- Science Toolbox Exploitation Platform | STEP

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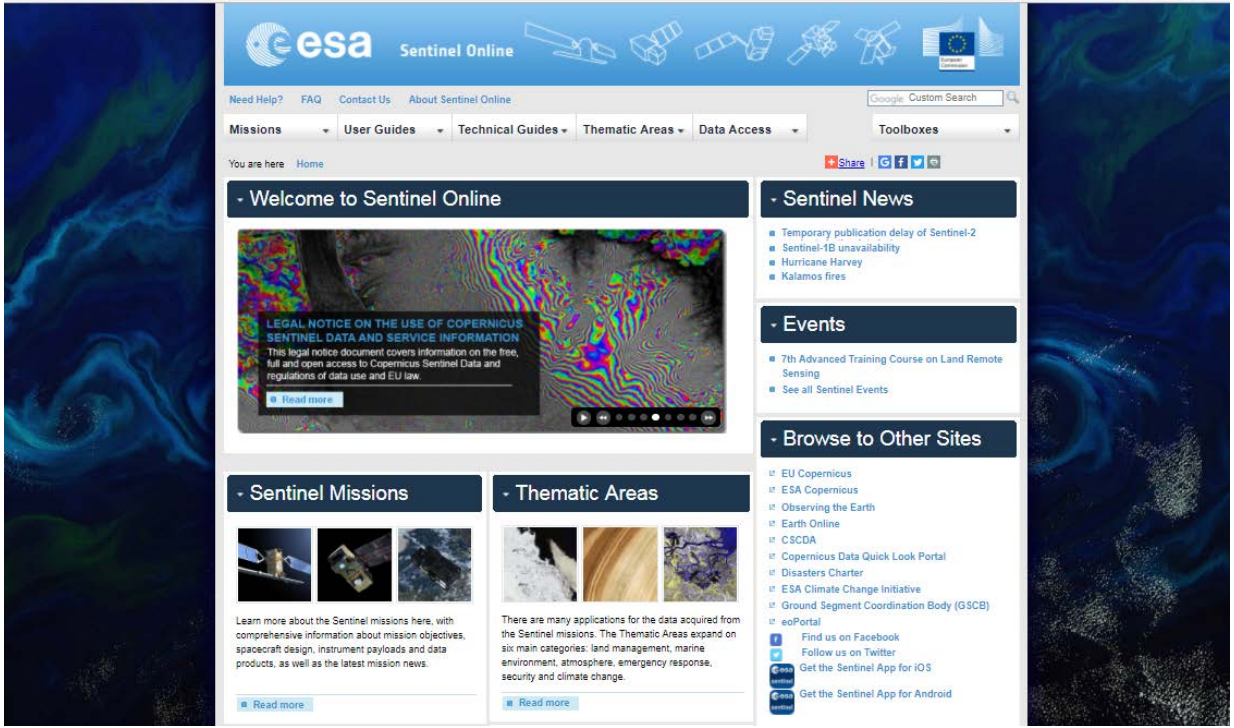
The Copernicus Programme
A Space Flagship Programme run by EU and ESA

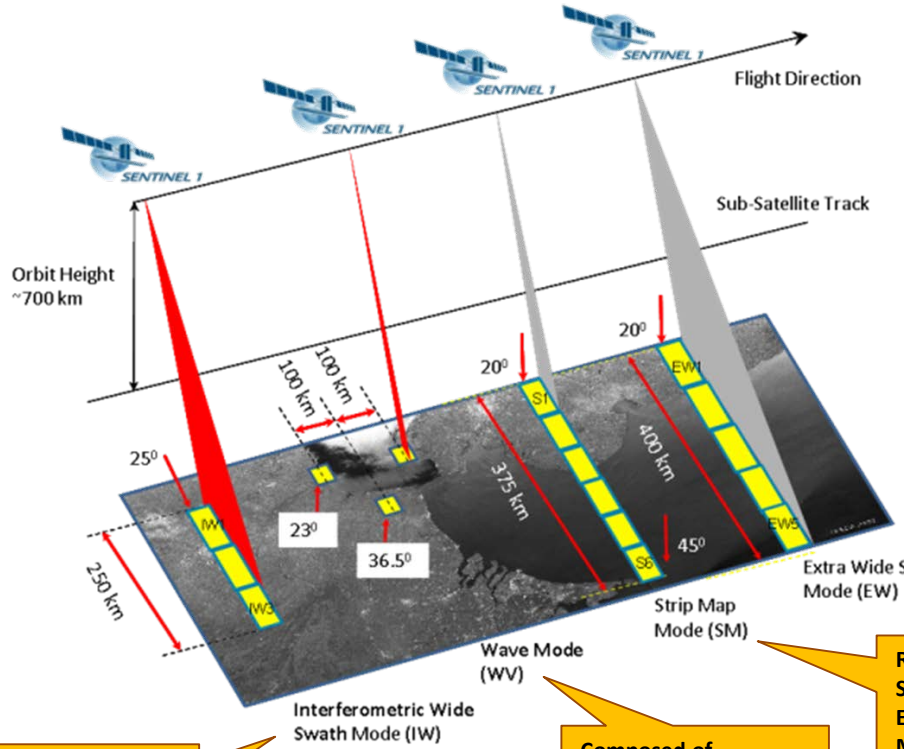
Sentinel Online | The Official Sentinel Website

https://sentinel.esa.int/web/sentinel/home



Sentinel online website provides technical guidelines for all sentinels, news and events related ,data access info and policy, last scientific results and more…

Sentinel-1 Mission Profile



S-1 SAR can be operated in 4 exclusive imaging modes with different resolution and coverages.

Resolution: 20 x 40m
Single and dual Polarisation
Polar areas, and ocean relevant areas
Can be used for interferometry

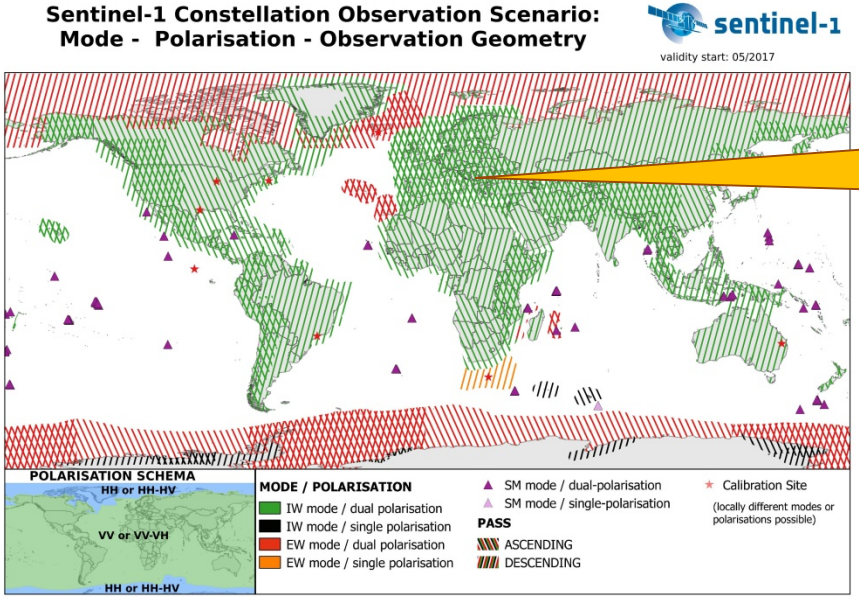
Resolution: 5m x 5m
Single and dual Polarisation
Emergency Services-Disater Monitoring

Resolution: 5m x20m
Single and dual Polarisation
Pre-defined mode over Land

Composed of Stripmap imagettes
Single polarisation
Pre-defined mode over open oceans

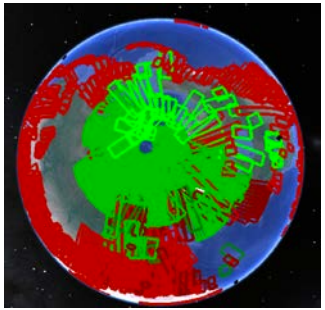
Sentinel-1 Observation scenario

Sentinels are operated via a pre-defined background observation plan published ahead of every repeat cycle as KML format at: https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-1/observation-scenario



Europe covered systematically every cycle, ascending and descending passes, IW mode, Dual polarisation

- **HH-HV or HH polarization for the monitoring of polar environments, sea-ice zones**
- **VV-VH or VV polarization for all other observation zones**



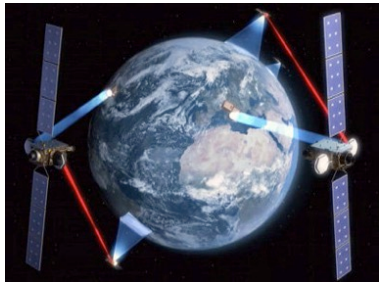
Operational use of European Data Relay System (EDRS)

The European Data Relay System service provides complementary acquisition of Sentinel-1 mission data addressing in particular:

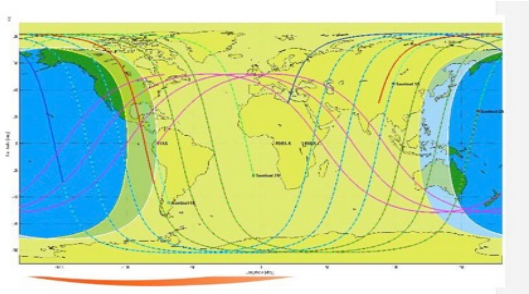
- **increased coverage**
- **enhanced timeliness, including quasi-real time** (QRT) observation capabilities, in particular outside Europe

The main functions provided by the service are:

- Sentinels mission **data transmission via Optical** (Laser) **link** to the GEO satellites
- Mission **data relay** between the GEO satellites and the Ka-band ground receiving terminals
- Mission **data reception, decommutation and provision** to the service interface point (Copernicus WAN circulation network)



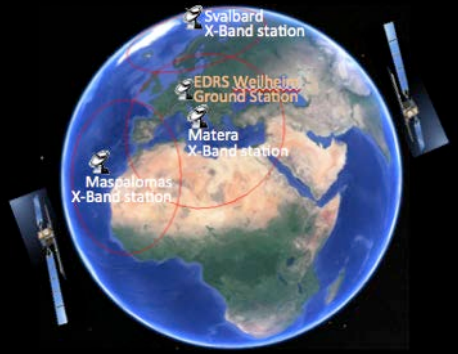
EUTELSAT 9B hosting EDRS-A



EDRS-Sentinels geometrical visibility map

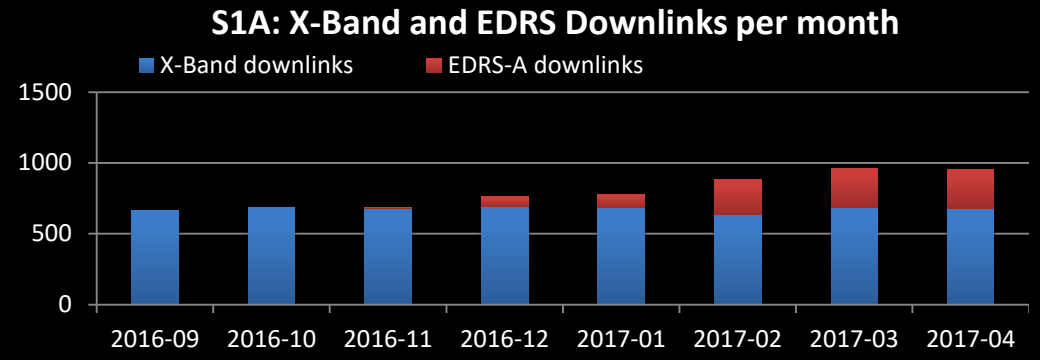
Sentinel-1/EDRS-A Operations

EDRS-A is operated as an additional downlink resource supporting Sentinel-1A and Sentinel-1B operations and brings a significant enhancement to the S1 operations, in particular:



More than 1000 EDRS-A/S1A operational downlinks performed to date

- ✓ Significant **increase in production volume** thanks to the additional downlink capabilities. Sentinel-1 products are being made available through the standard on-line data access mechanisms
- ✓ Increased observations (e.g. revisit) and SAR dual polarisation acquisitions
- ✓ significant increase of Sentinel-1 pass-through acquisitions in X-Band over Europe



Sentinel-1 Systematic GLOBAL processing for IW SLC

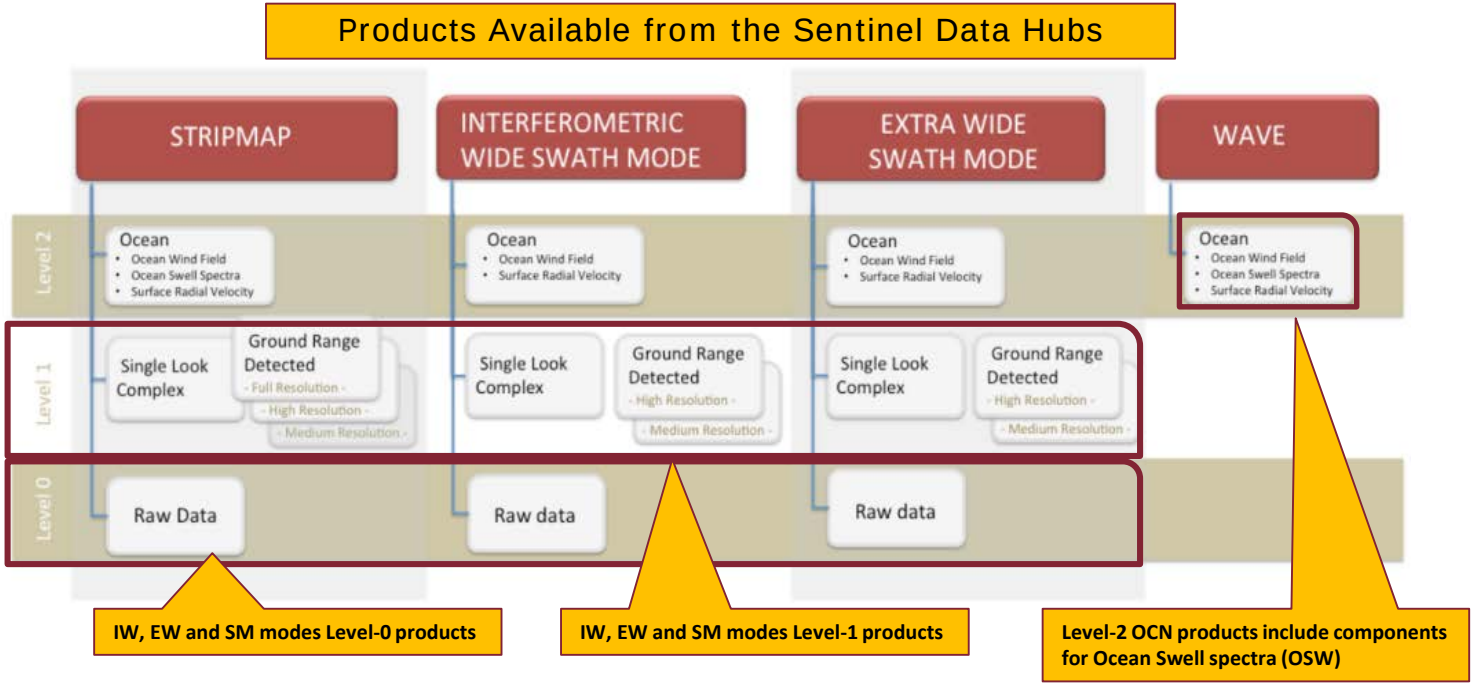
- Backwards processing of IW SLC over areas not included in the SLC processing scenario since 2014.10.06 has started in started in summer 2016

- Missing IW SLC for all areas in the past have being gradually made available on-line during 2016
- On-line availability of IW SLC products for all S1A data acquired since Oct. 2014 over land and ice masses has been completed in November 2016.

All Sentinel-1 data acquired in IW over Land and Ice masses since the Sentinel-1A data access opening is now available on-line to all users.

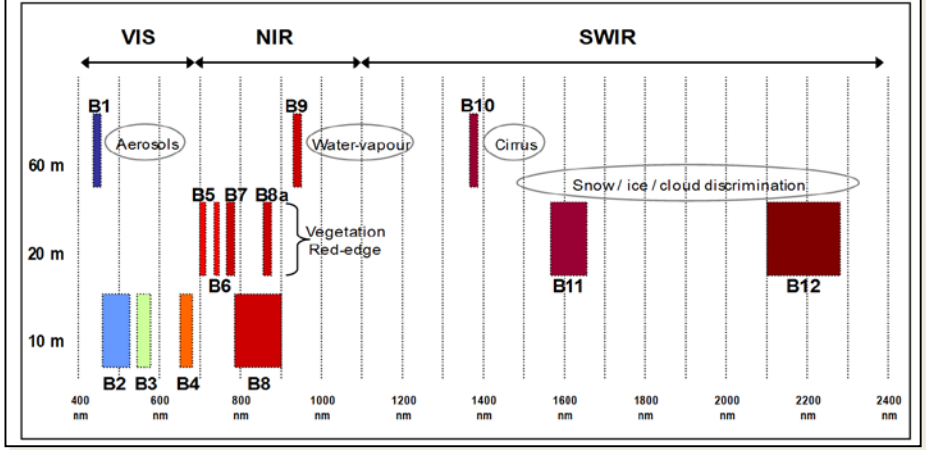
Sentinel-1 Production Scenario

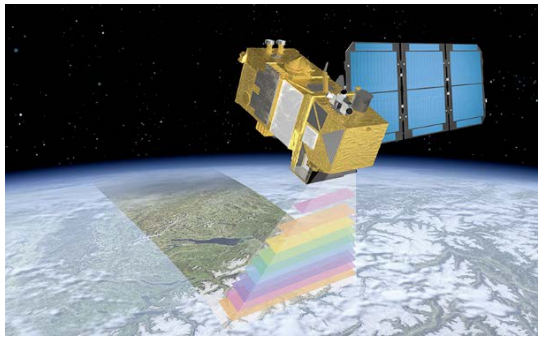
All Sentinels acquired data is systematically downlinked and processed to generate a predefined list of core products within specific timeliness

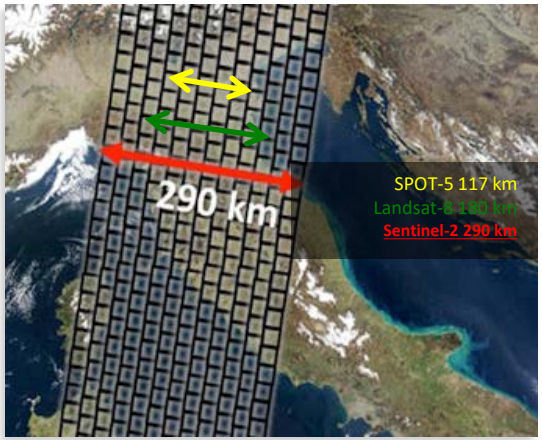


Sentinel-2 Mission Profile

High Resolution Optical Mission - Multispectral Imager (MSI) Instrument



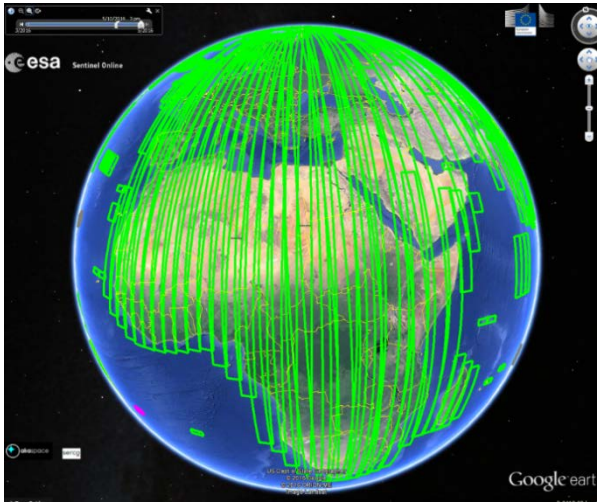


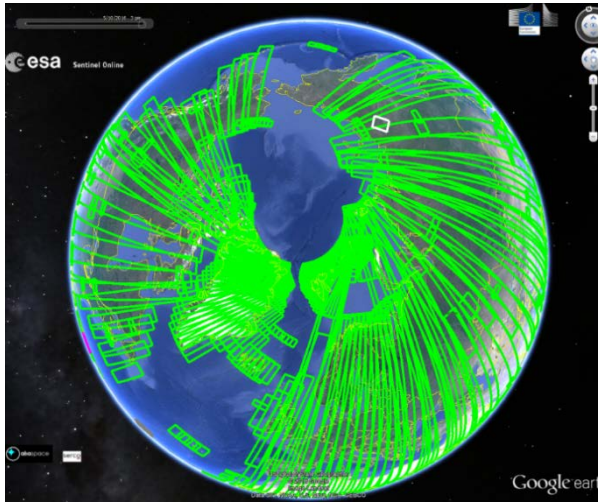


- 13 spectral bands in the Visible (VIS), Near Infrared (NIR), Short Wave Infrared (SWIR)
- Ground pixel resolution of 10m, 20m, 60m (for atmospheric correction) across a 290 km swath

Sentinel-2 Observation scenario

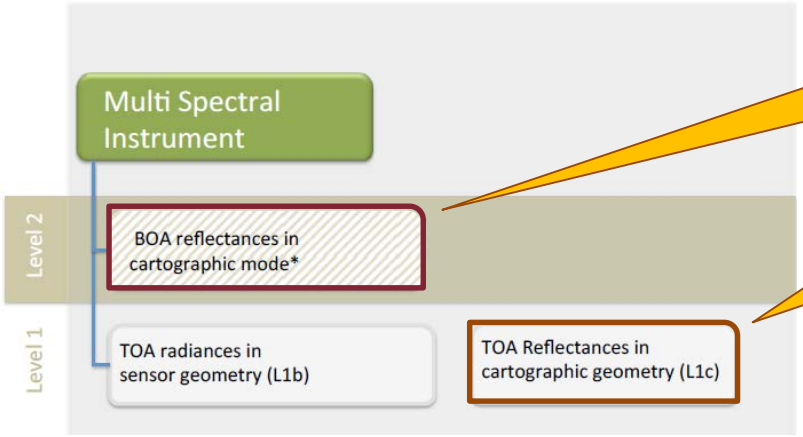
Regularly published online in KML format at:
https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-2/acquisition-plans





- High Revisit (10 days) at the equator with one satellite - 5 days with 2 satellites (2-3 days at mid-latitudes)
- Sentinel-2 systematically covers all land surfaces (56° South latitude - 84° North latitude)
- Europe & Africa systematically covered on every orbit
- The rest of the world within a certain time interval: currently 30 days, will be progressively reduced over the coming months to reach 10 days.

Sentinel-2 Production Scenario



L2a BOA reflectances are generated at users' side by a processor running on ESA's Sentinel-2 Toolbox

Systematic processing and online dissemination of all Level-1c Products available from the Sentinel Data Hubs

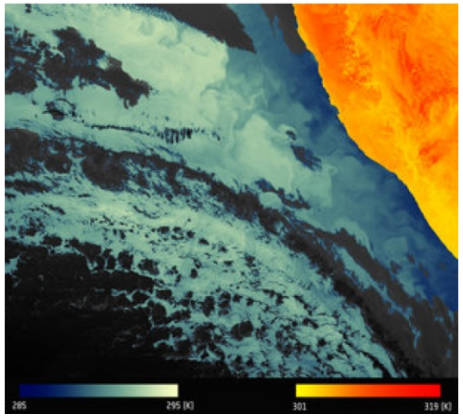
Sentinel 2 Toolbox – L2b Biophysical Products

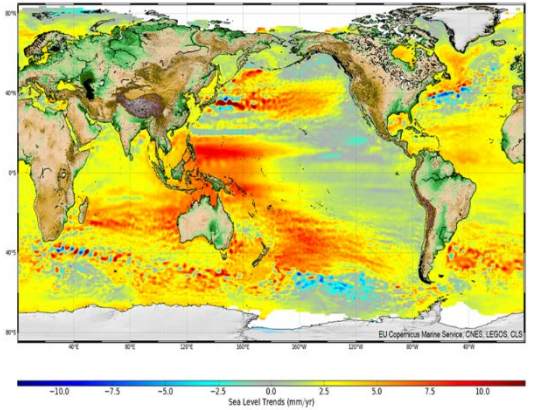
- **LAI:** Leaf Area index
- **FAPAR:** Fraction of Photosynthetically Active Radiation
- **CCC:** Canopy Chlorophyll Content
- **CWC:** Canopy Water Content

L1c Product Tile Composition

Sentinel-3 Mission Profile

Operational Oceanography & Global Land Application





Optical Payload

OLCI (Ocean and Land Color Instrument)

SLSTR (Sea and Land Surface Temperature Radiometer)

Data continuity of the Vegetation instrument (on SPOT4/5), Enhanced fire monitoring capabilities

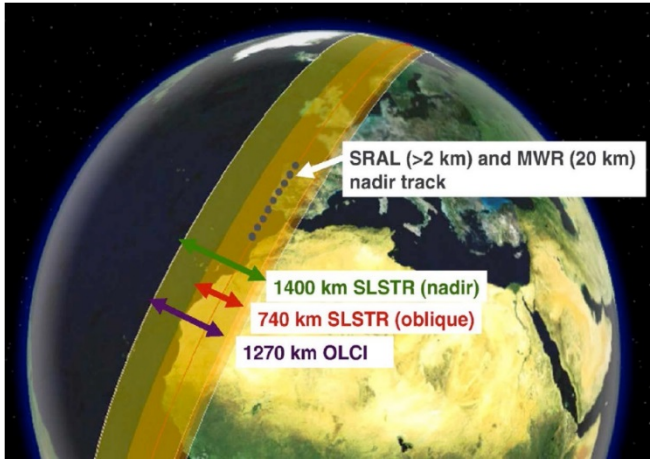
Topography Payload

SRAL (Synthetic Radar Altimeter) **Sea surface topography data**

MWR (Micro Wave Radiometer)

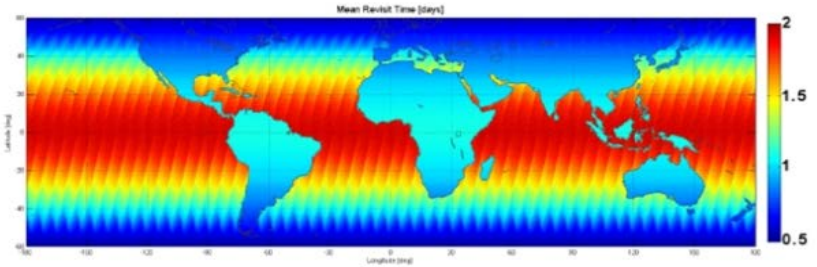
POD
Precise Orbit Determination

Sentinel-3 Observation scenario

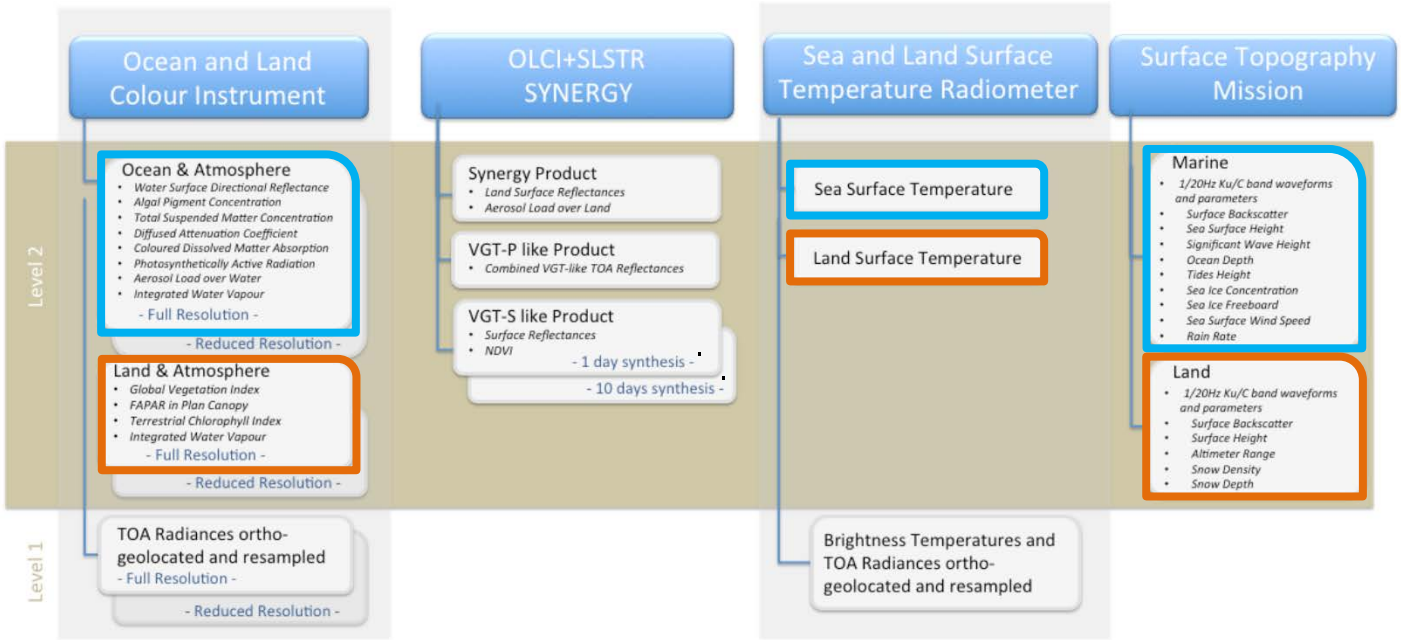


- Sentinel 3 Systematic Processing and dissemination in NRT
- The OLCI instrument acquires data over daylight part of the orbit
- SLSTR, SRAL and MWR acquired data over the whole orbit

Revisit at Equator	
Ocean Colour	< 1.9 days
Land Colour	< 1.1 day
SLST	< 0.9 day



Sentinel-3 Production Scenario



ESA disseminates the S-3 L1 & L2 Land Products

Eumetsat disseminates the S-3 L1 & L2 Marine Products

- Copernicus Sentinel Missions
- Historical Missions Data Access
- Sentinel Data Access
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Facilitating Access to EO data

A constant ESA objective:

→ ***Ease access to Earth Observation data***

1. ESA EO data policy:
   → free of charge, open (and of high quality)
2. Constant upgrade of ground segment for easier access to EO data including Near Real Time (NRT) and reprocessing
3. Need to address "heritage" data for future use

→ ***Need to anticipate the way users will use EO data in future (e.g. exploitation platform, data/algorithm toolboxes)***

ESA Earth Observation Data Policy | **PAST**

To stimulate a balanced development of Science, Public Utility and Commercial Applications, consistent with the mission objectives

To maximize the beneficial use of data from ESA EO satellites

ERS and Envisat

Earth Explorers

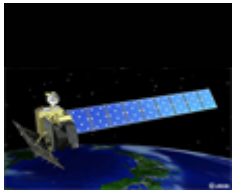
ESA Data Policy

Free datasets

Open access and free of charge. User registration and acceptance of ESA Terms & Conditions are required

Restrained datasets

Free of charge. The submission of a Project (Full) Proposal and acceptance of the ESA Terms & Conditions are required, after its evaluation a quota will be assigned



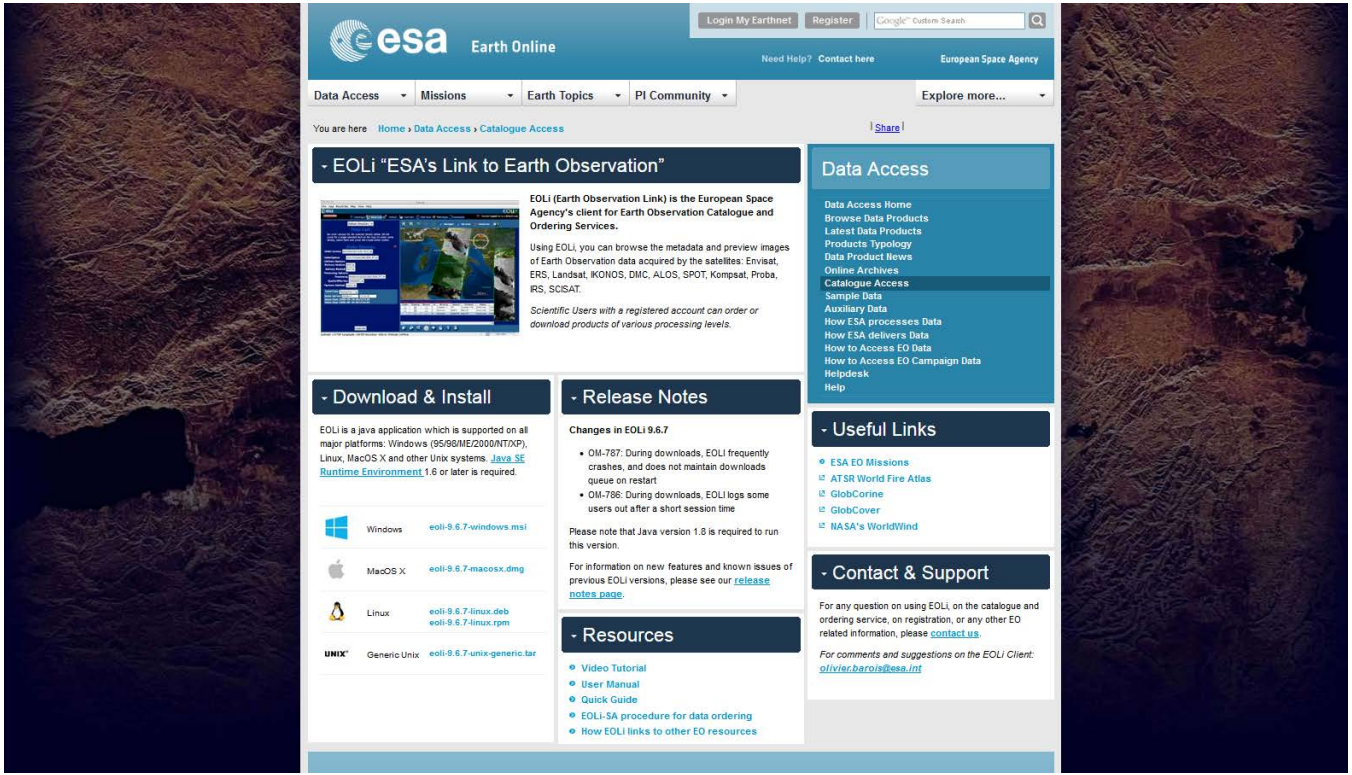
ESA Third Party Missions

Data Policy of individual data providers

In some case a reproduction cost (e.g. ALOS) or Specific Restrictions (limitations of quota, geographical restrictions, etc.) to the use of data may be applied for TPM

Historical Missions Data Access

ESA Link to Earth Observation | **EOLi**



ERS/ENVISAT (A)SAR - How to Obtain (A)SAR OTF Data

(A)SAR **On The Fly** data products are freely available to ESA registered users via the EOLI-SA client.

Users can search and browse all products openly, but a registration on the ESA EO Data Portal is order required to download.

In order to register and to be granted access to the available products, users are required to follow the steps below:

- Create an EO-SSO account following the instructions (for users who have not registered already).
- Apply for (A)SAR OTF Data
  - **Level 1 (ASAR_IMS - ASAR_IMP - ASAR_APS - ASAR_APP)**
    Users can access (A)SAR OTF Standard Service (Level 1 data products) by submitting a Fast Registration.
    Access will be automatically enabled at registration submission. Users will receive an email containing access details.
  - **Level 0 (ASAR_IM - ASAR_APC - ASAR_APH - ASAR_APV)**
    Users can access (A)SAR OTF Level 0 data products by submitting a Data Service Request justifying and describing the data needs. **Please note that access** to Level 0 Data is not part of the standard OTF Service and it will be granted in exceptional cases. Requests will be evaluated and feedback will be provided usually within 2 weeks.

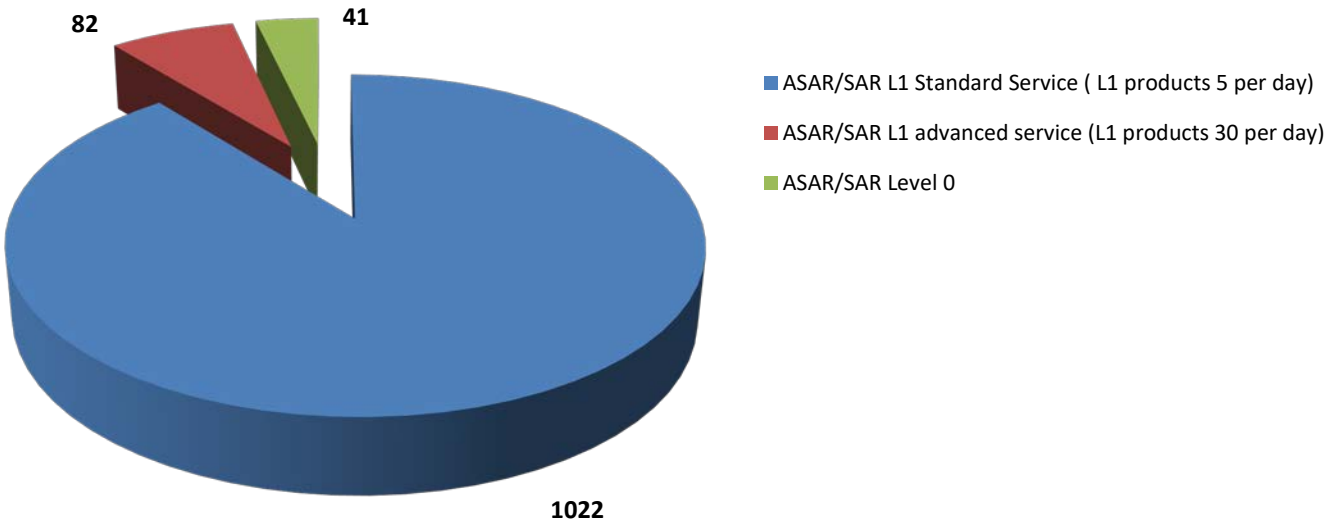
The service is being rolled out gradually *(ASAR WS from December 2016, and ERS IM from Q1 2017).*

Quality of Service : In order to allow a fair share of resources the dissemination system allows data download with the following rules:

- Users can download only a fixed number of products per day (from 00:00 to 23:59 UTC) – *Standard service up to **5** products per day*
- Users can perform only a limited number of requests or download in parallel

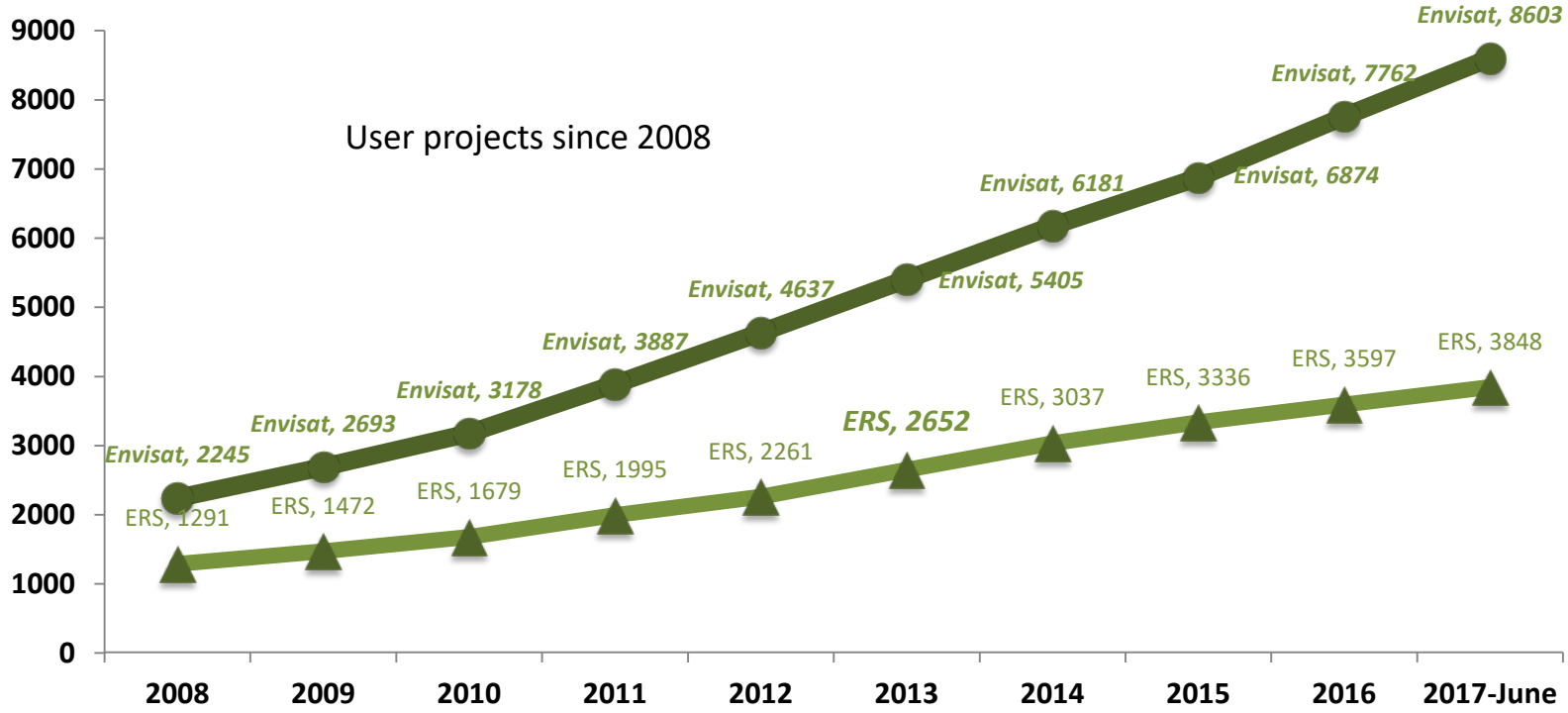
Because not all online disseminated data is immediately available for download, as there might be products that need to be processed, the consumption of daily quota occurs already when the product is requested and not when the download begins. However, even if daily quota is over, users are allowed to download the products already requested or not yet available at request time.

(A)SAR **On The Fly** system new users (opened in July 2016)

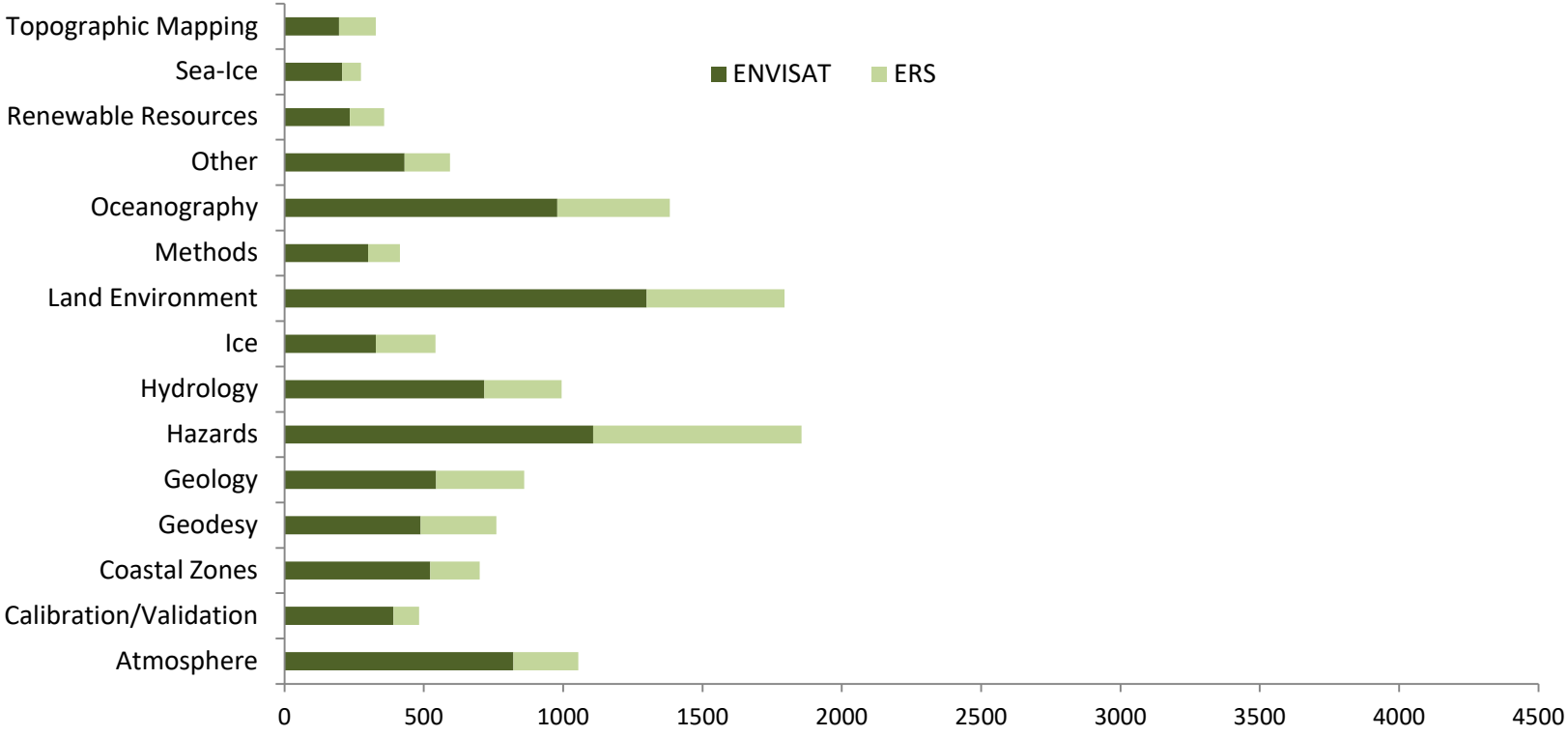


Note: Please consider that Old/already existing PIs have been migrated to the new (OTF) system with corresponding download rights for ASAR and SAR Level 1 and Level 0 products

Evolution of ERS and ENVISAT user project



Distribution of ENVISAT and ERS user projects by Application Domain



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The Copernicus Space Component

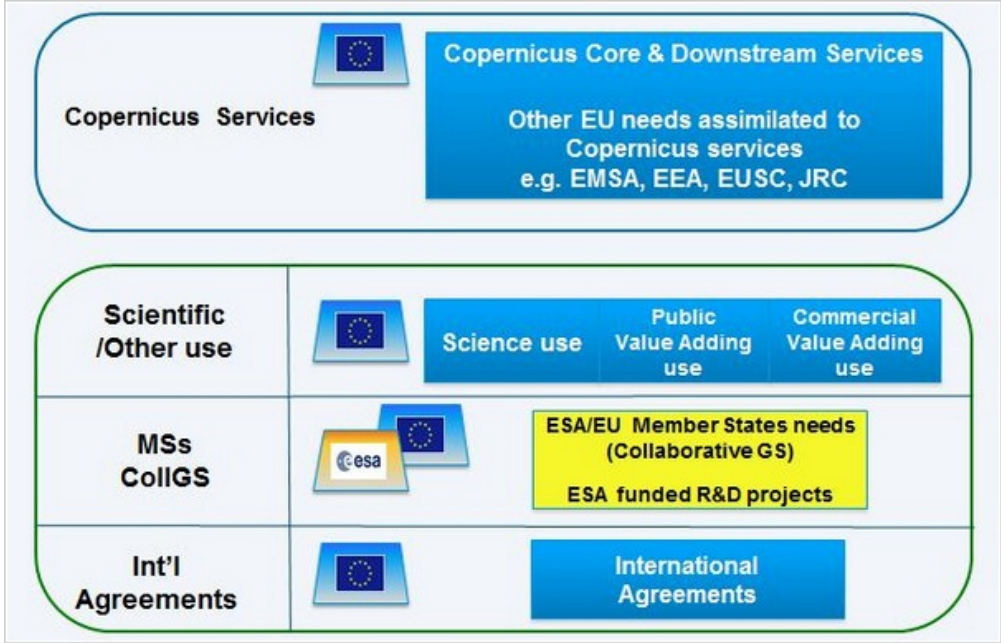
Dedicated Sentinel Missions Data Access System

Contributing Missions (CCMs) Data Access System

CORE and ADDITIONAL datasets may be accessed depending on user categories' access rights

Sentinel data access | Use typologies and the corresponding services/data access (overview)

Typologies are defined for Sentinel data access



Register for use by Copernicus services via CSCDA → https://spacedata.copernicus.eu

Register for Other/Scientific use via Sentinel-1 Scientific Data hub → https://scihub.copernicus.eu

Copernicus Sentinel Data Policy

Copernicus Data Policy for Sentinels Missions

- The Copernicus data policy is adopted via a Delegated Regulation
- This policy promotes the access, use and sharing of Copernicus information and data on a full, free and open basis
- One of the main objectives is to support downstream segment and research, technology and innovation communities
- The European research institutes will be able to make the best use of these data to create innovative applications and services

Sentinel Data Policy = full and open access to Sentinel data to all users

In practical terms

- **Anybody can (has the right to) access acquired Sentinel data**
- **Licenses for the Sentinel data are free of charge**
- **Online access with users registration including acceptation of T&C***

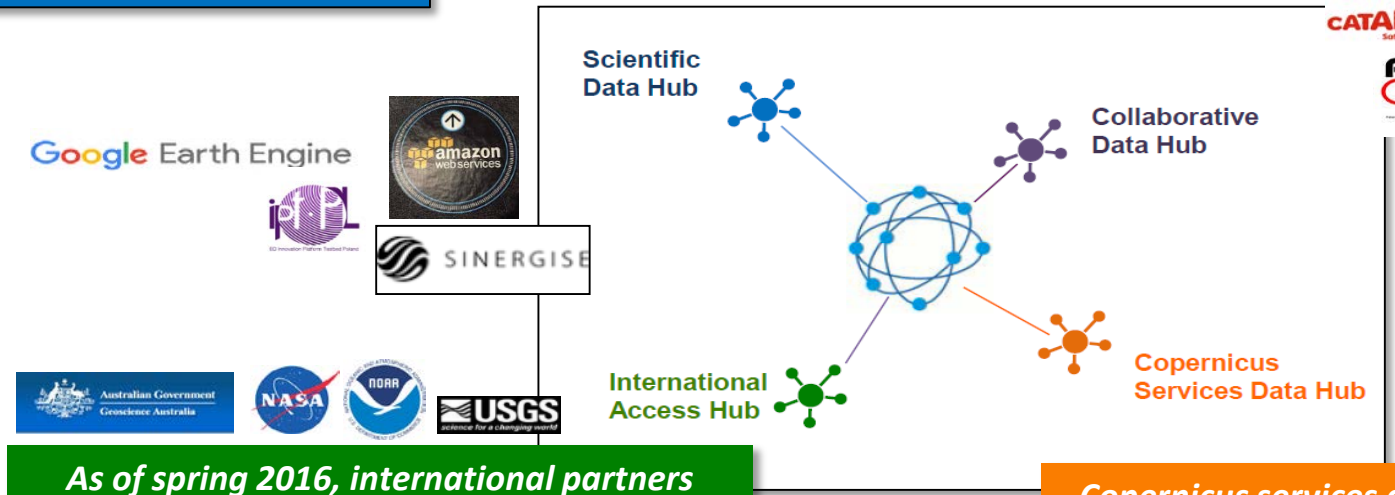
* *TERMS AND CONDITIONS FOR THE USE AND DISTRIBUTION OF SENTINEL DATA available online on the Sentinel website (https://sentinel.esa.int/documents/247904/690755/Sentinel_Data_Legal_Notice)*

Copernicus Data Access & Redistribution

Private companies are re-distributing Sentinel products/images via free and pay-per-use schemes

The open access Data Hub, for *anyone (82,000 users)*

Collaborative mirror sites directly serve 900+ users (status end 2016)



Google Earth Engine

amazon web services

SINERGISE

Australian Government Geoscience Australia

NASA

NOAA

USGS

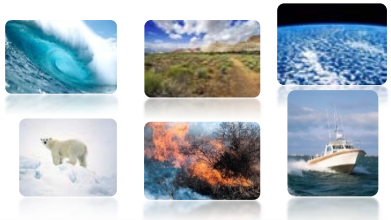
CATAPULT Satellite Applications

peps

Find CEDA Data

OPUS

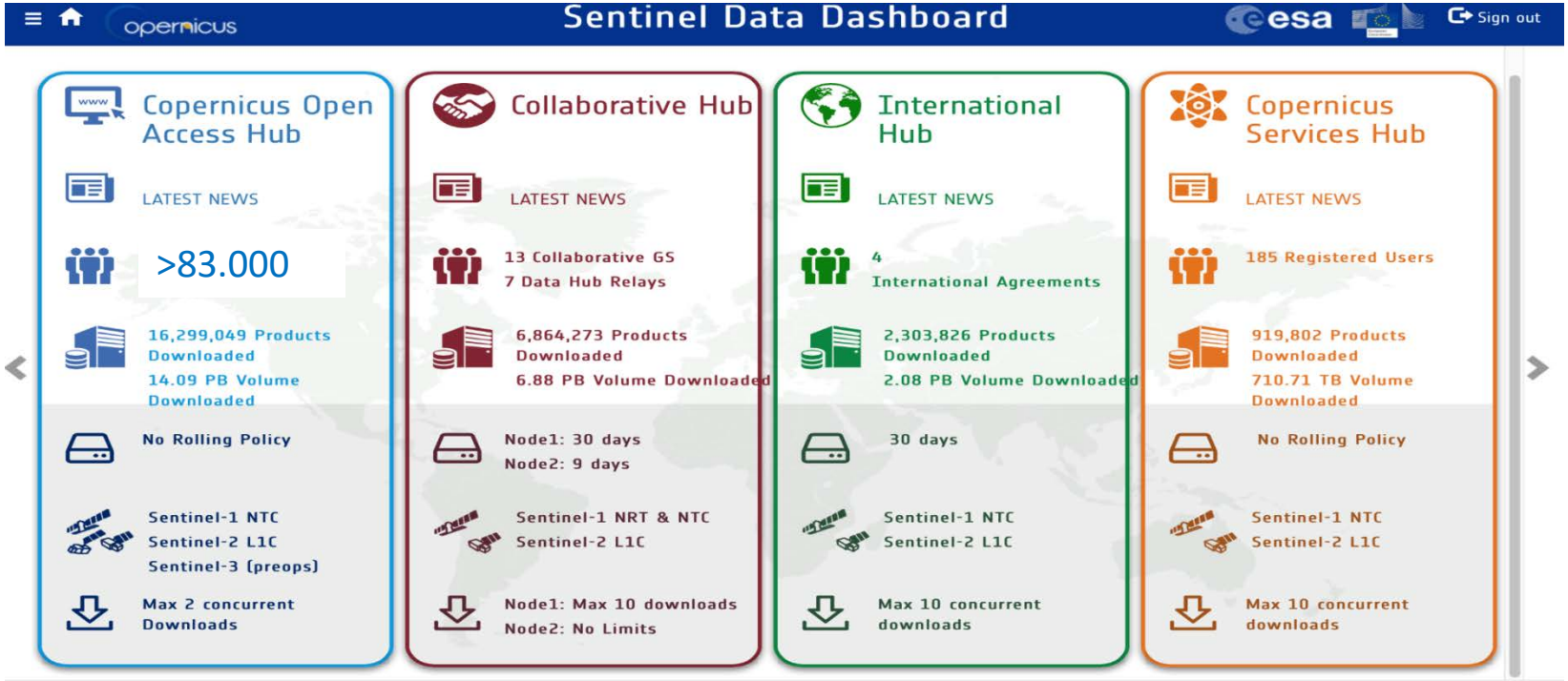
FMI



As of spring 2016, international partners mirror sites have started disseminating towards own national communities

Copernicus services are providing their higher level products to ~10,000 users (status Q1 2016)

Sentinel Data Hubs – Configuration
Sentinel Data Hubs operated by ESA



Sentinel Data Access for Scientific Users | Open Access Hub

The free, full and open data policy adopted for the Copernicus programme foresees access available to all users for the Sentinel data products, via a simple registration.

Users can register and download Sentinel-1 data from the online Sentinel Data Hub (https://scihub.copernicus.eu/).

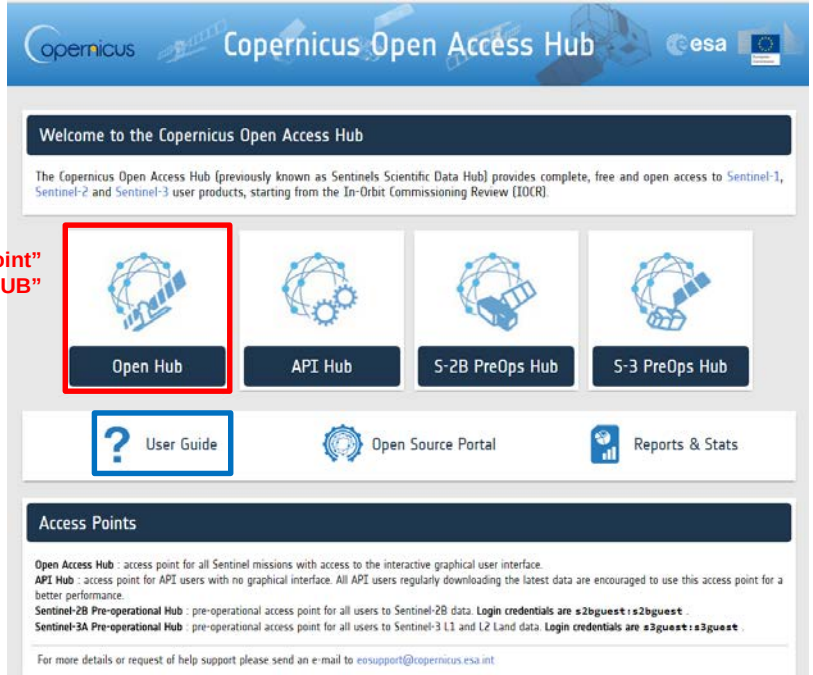
Anyone can register online via self-registration. The self-registration process is automatic and immediate. Registration grants access rights for searching and downloading Sentinels products. Sentinel-1 and Sentinel-2 (coming soon Sentinel-3) products are available at no cost for anybody. The data available through the Data Hub is governed by the Terms and Conditions of the use and distribution of Sentinel data, which the User is deemed to have accepted by using the Sentinel data.

More technical https://scihub.copernicus.eu/userguide/

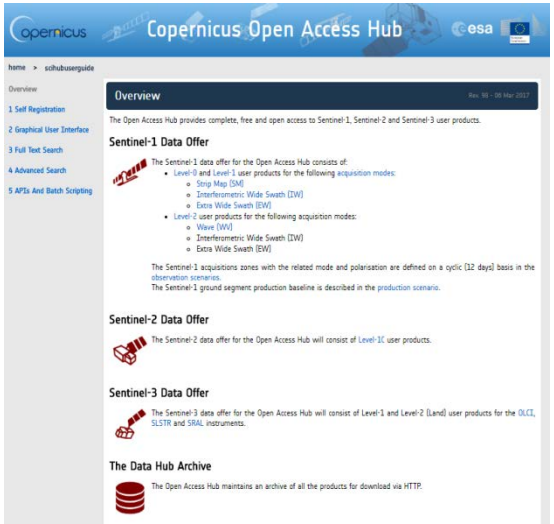
Copernicus (Sentinel) Open Access Hub (1/5)

S1/S2 and S3 data are available to all users via Sentinel Open Access Hub

"Access point"
click on "Open HUB"

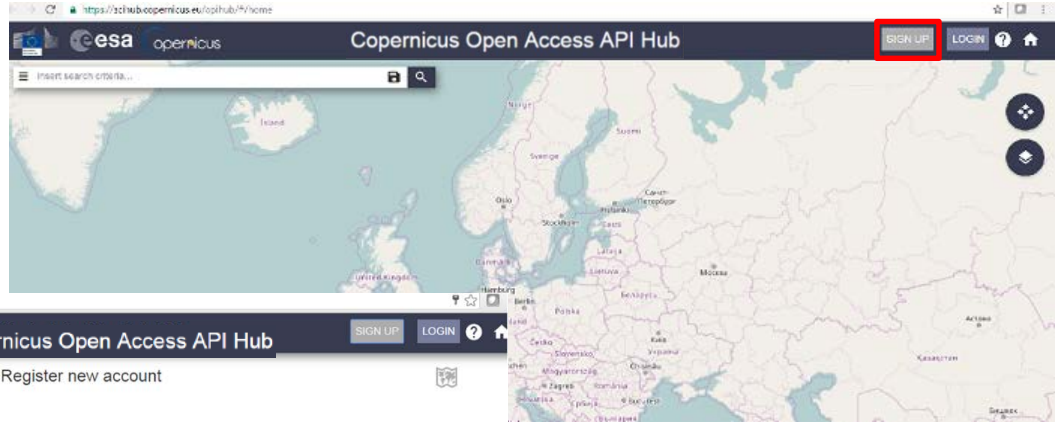


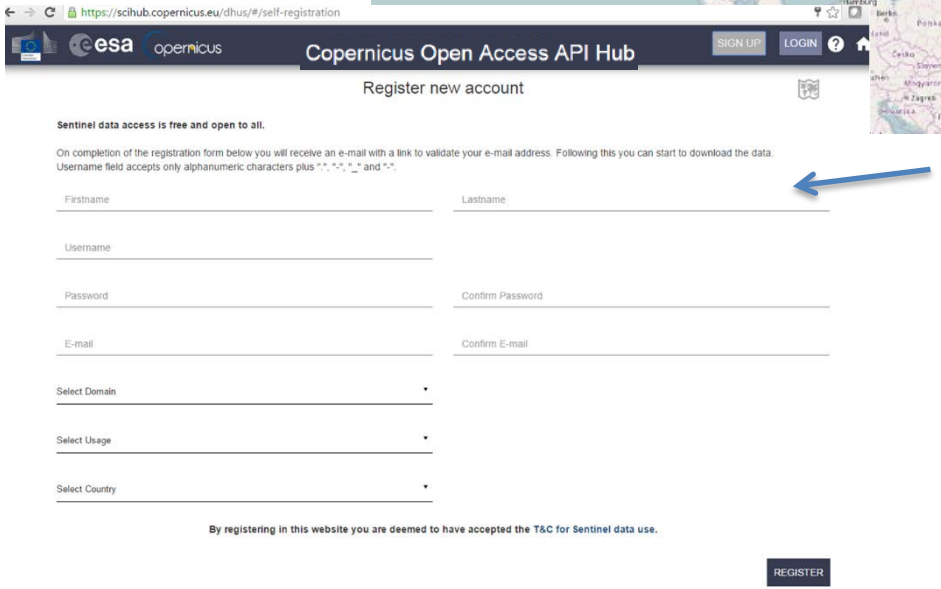
User Guide



Copernicus (Sentinel) Open Access Hub (2/5)

If you are already registered log in to start using the Sentinel Hub geographic interface to browse and download Sentinel data, if you are a new user click on the circled red link “SIGN UP” to complete registration





Fill this form to start registration procedure (username and e-mail address should be provided in lower case only) then you will receive a mail with a link to validate your mail address. Finally an administrator will be able to let you access to the Sentinel Data Hub.
Please note that by registering in this website you are deemed to have accepted the T&C for Sentinel data use.

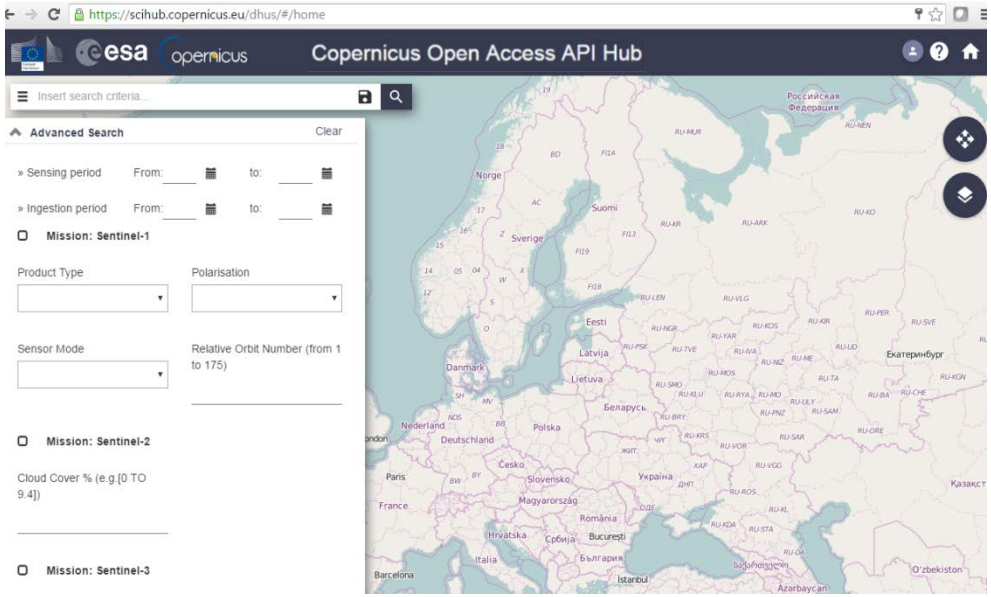
https://sentinel.esa.int/documents/247904/690755/Sentinel_Data_Terms_and_Conditions)

Copernicus (Sentinel) Open Access Hub (3/5)

Once completed registration you can log in and use the “Advanced search” criteria, start use Sentinel hub interface to search and download sentinels data .

Search criteria available:

- Draw region of interest
- Full text search
- Advanced search (product, type, acq.dates, etc.)



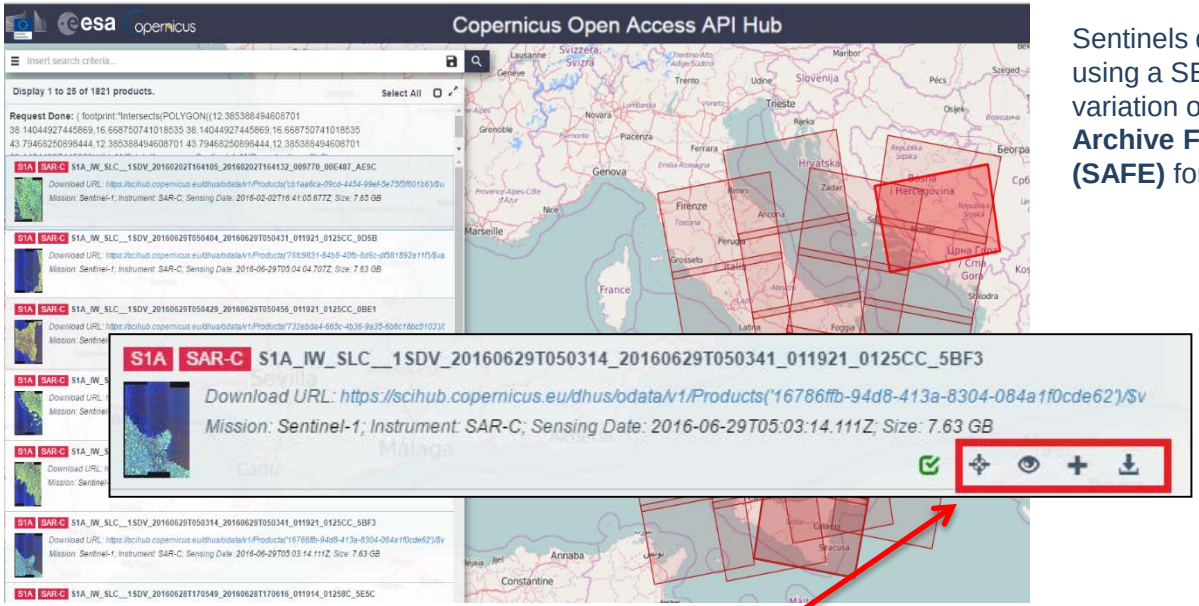
Sentinels Scientific Data Hub

The Sentinels Scientific Data Hub is a web based system designed to provide EO data users with distributed mirror archives and bulk dissemination capabilities for the Sentinels products.

Terms of Sentinels Scientific Data Hub portal and Data supply conditions

Full details on **Sentinel Online** at: https://sentinel.esa.int/

Copernicus (Sentinel) Open Access Hub (4/5)

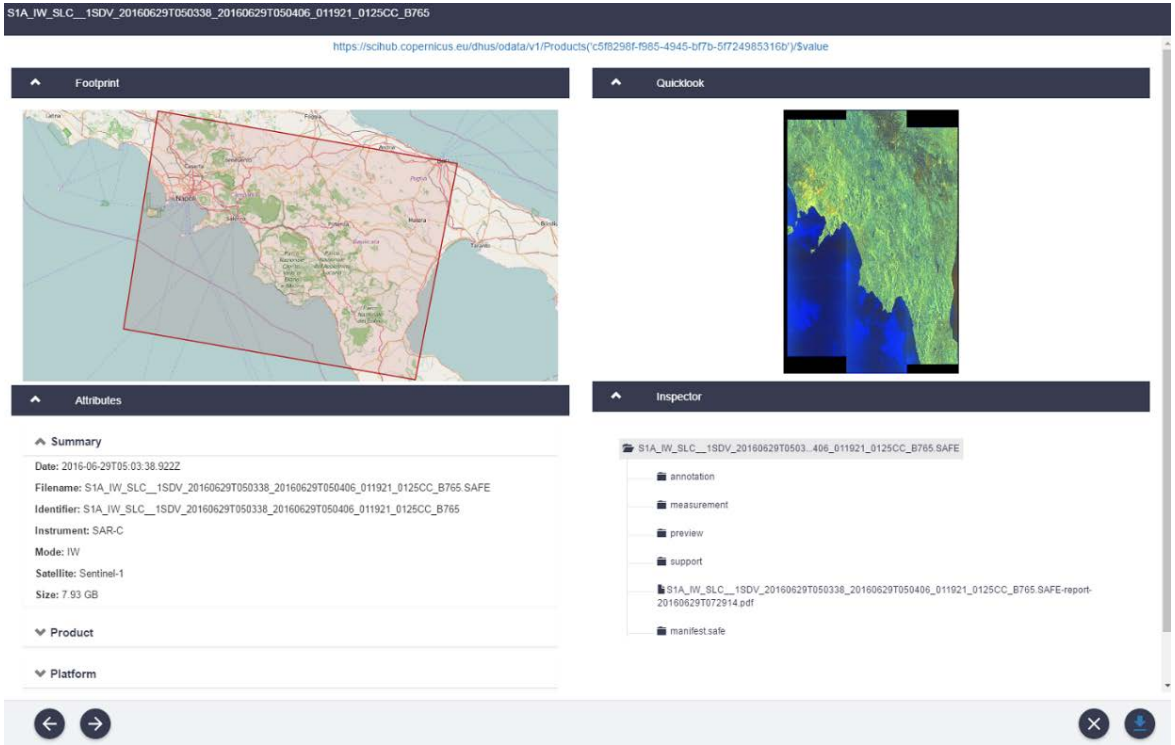


Sentinels data are distributed using a SENTINEL-specific variation of the **Standard Archive Format for Europe (SAFE)** format

Select product of you interest and use the icons to (the circled red icons): Zoom in the map, view product details, move it in the 'Cart' or "Download product"

Click and download, shopping cart, batch download.
A maximum of 2 concurrent downloads per user is allowed in order to ensure a download capacity for all users.

Copernicus (Sentinel) Open Access Hub (5/5)

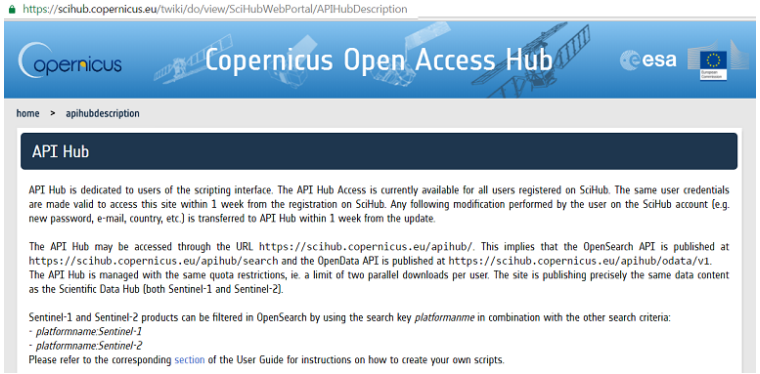


View product details is an online inspection of the searched products by browsing and pre-viewing the product metadata and measurements without downloading it. A preview panel displays information on the product contents and structure.

API Hub

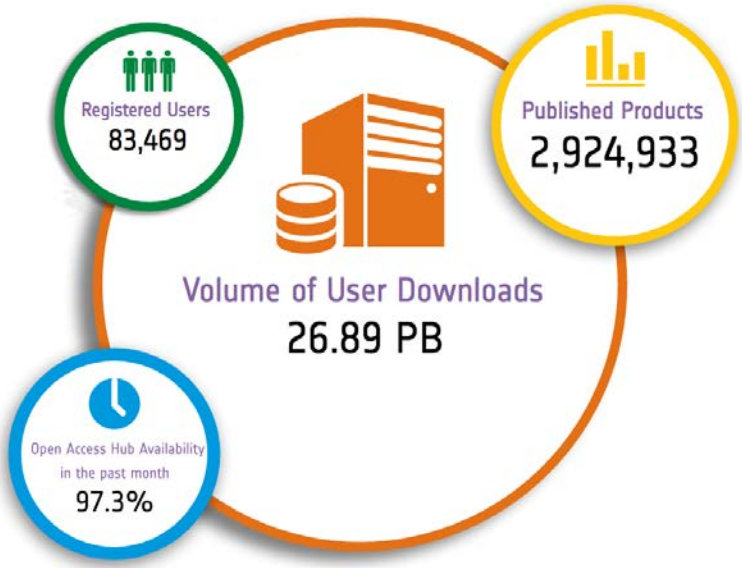
APIs And Batch ScriptingRev. The Data Hub exposes two dedicated Application Program Interfaces (API) for browsing and accessing the EO data stored in the rolling archive. The APIs are: Open Data Protocol (OData) & Open Search (Solr)
The OData interface is a data access protocol built on core protocols like HTTP and commonly accepted methodologies like REST that can be handled by a large set of client tools as simple as common web browsers, download-managers or computer programs such as**cURL** or **Wget** .

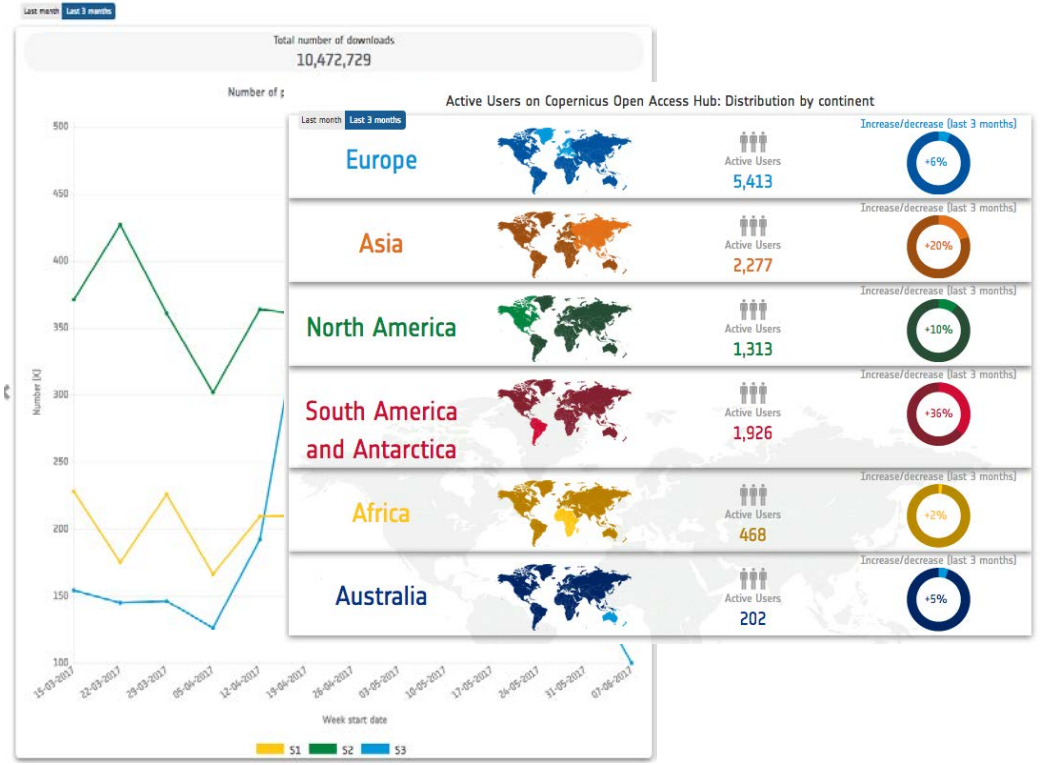
OpenSearch is a set of technologies that allow publishing of search results in a standard and accessible format. OpenSearch is RESTful technology and complementary to the OData. In fact, OpenSearch can be used to complementary serve as the query aspect of OData, which provides a way to access identified or located results and download them.



API Hub : access point for API users with no graphical interface. All API users regularly downloading the latest data are encouraged to use this access point for a better performance.

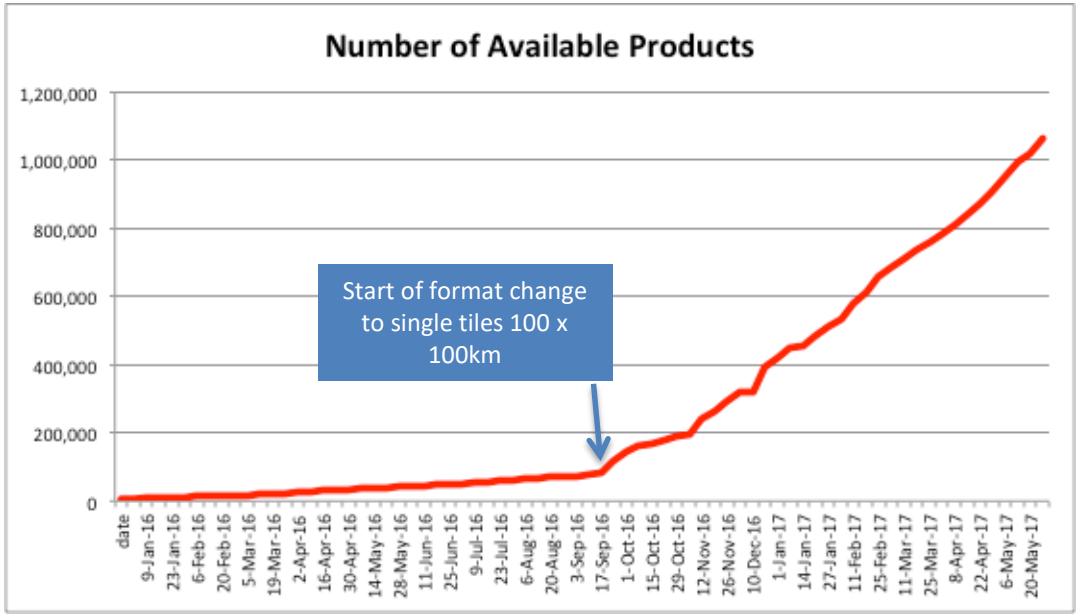
Sentinel Open Access Data Hub

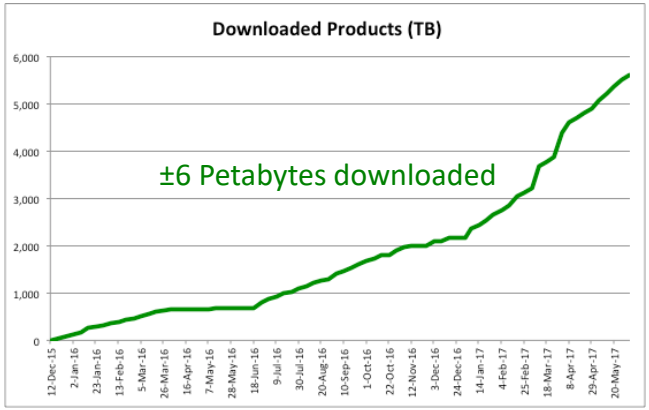




Stats on June 2017

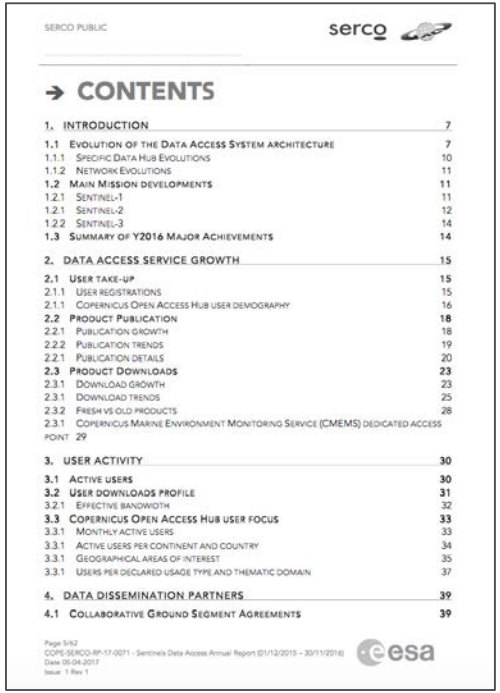
Sentinel-2 Data Access (since Dec 2015)





More than 6.000.000 Sentinel-2 products downloaded by the time of S2B launch!

Annual Data Access Report online



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COPE-SERCO-RP-17-0071 - Sentinels Data Access Annual Report (01/12/2015 – 30/11/2016)
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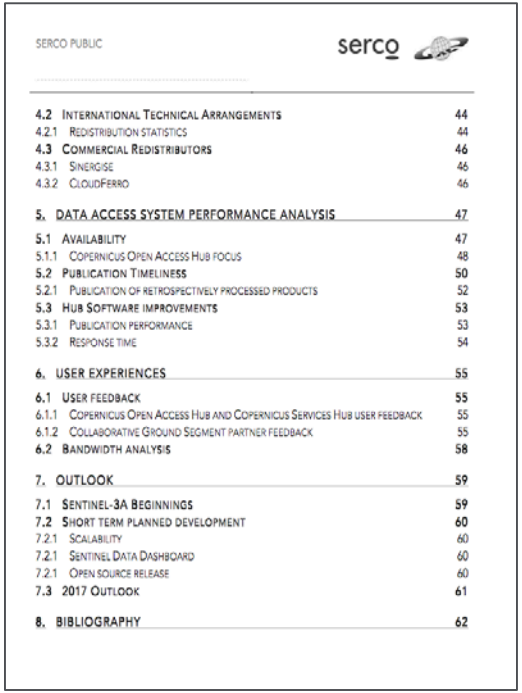

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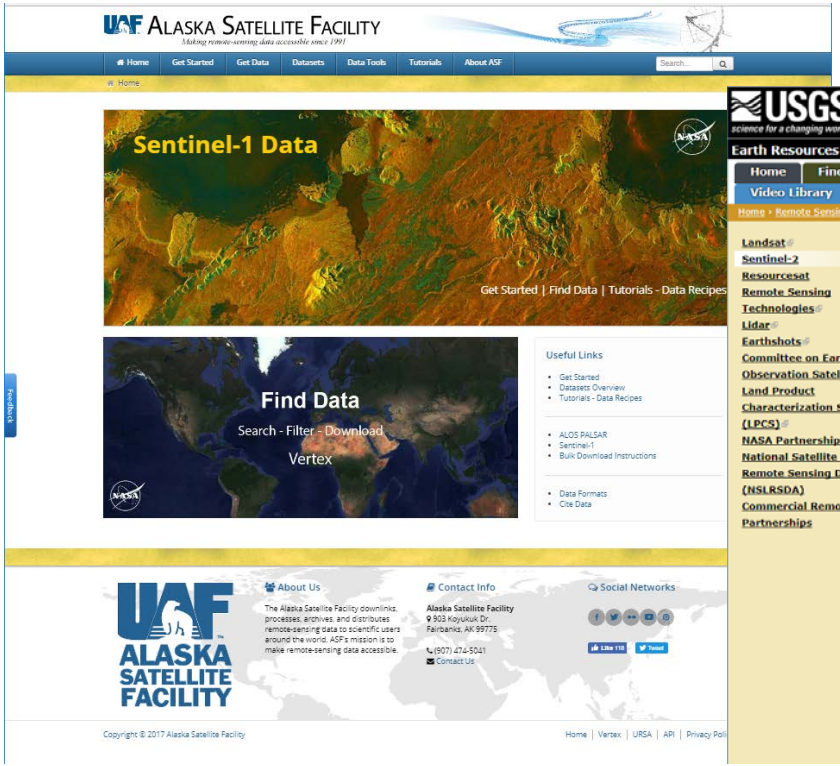
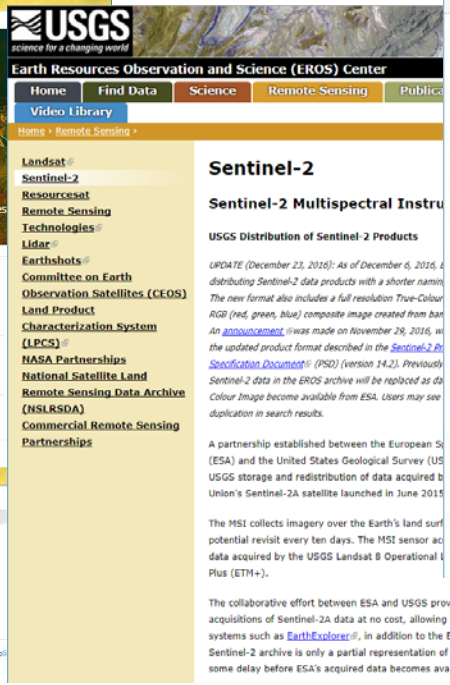
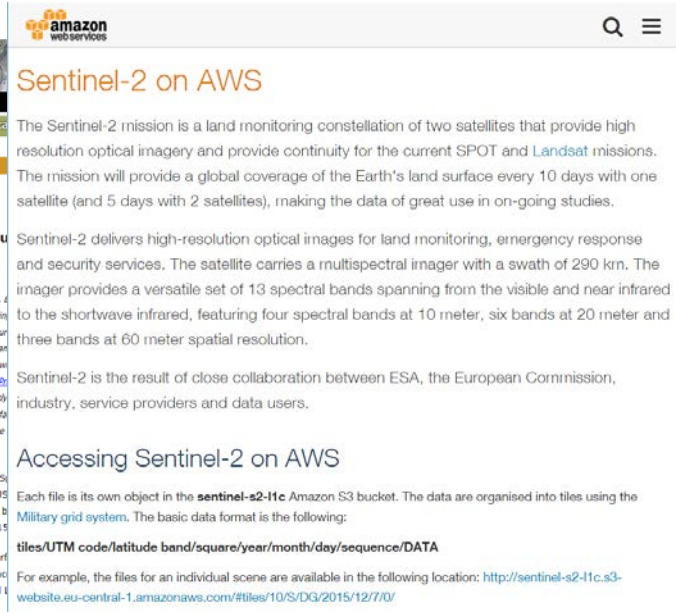
https://sentinels.copernicus.eu/documents/247904/2955773/Sentinel-Data-Access-Annual-Report-2016

Copernicus Sentinel Data | Alternative Dissimination Sources







- Copernicus Sentinel Missions
- Historical Missions Data Access
- Sentinel Data Access
- Sentinel Application Platform | SNAP
- Science Toolbox Exploitation Platform | STEP

SNAP

- The common architecture for all **Sentinel Toolboxes** and **SMOS Toolbox** is called Sentinel Application Platform (SNAP).
- SNAP architecture is ideal for Earth Observation processing and analysis due the following technological innovations: Extensibility, Portability, Modular Rich Client Platform, Generic EO Data Abstraction, Tiled Memory Management and a Graph Processing Framework.

Activity initially funded through SEOM element of ESA's EOEP-4 (www.seom.esa.int)

seom
scientific exploitation of operational missions

SNAP Development History

Built on pr
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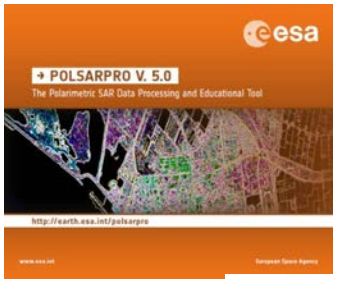
User Developed Plugins

ESA Polarimetric SAR Data Processing and Educational Tool



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Multi-Mission Scientific Platform

Development Consortia

ARRAY SYSTEMS COMPUTING INC.

- BROCKMANN CONSULT GMBH
- DLR
- oceandatalab

CS La force de l'innovation

- CS ROMÂNIA
- TELESPAZIO VEGA DEUTSCHLAND A Finmeccanica / Thales Company
- INRA SCIENCE & IMPACT
- UCL Université catholique de Louvain

BROCKMANN CONSULT

- University of Reading
- CS La force de l'innovation
- ACRI ST
- ARRAY SYSTEMS COMPUTING INC.

seom scientific exploitation of operational missions

Sentinel Application Platform | SNAP

- **SAR Toolbox (S1TBX)**
  - Scientific toolbox for the handling and post-processing of data products from Sentinel-1 SAR mission
- **High Resolution Optical Toolbox (S2TBX)**
  - Toolbox for the visualisation, analysis and post-processing of data products from Sentinel-2 multi-spectral optical data
- **Medium Resolution Optical Toolbox (S3TBX)**
  - Toolbox for the processing and analysis of Sentinel 3 OLCI and SLSTR
- Developer forum
  - Requirements addressing a common platform issues
  - Define the platform roadmap
  - Coordinate horizontal activities across the three toolboxes

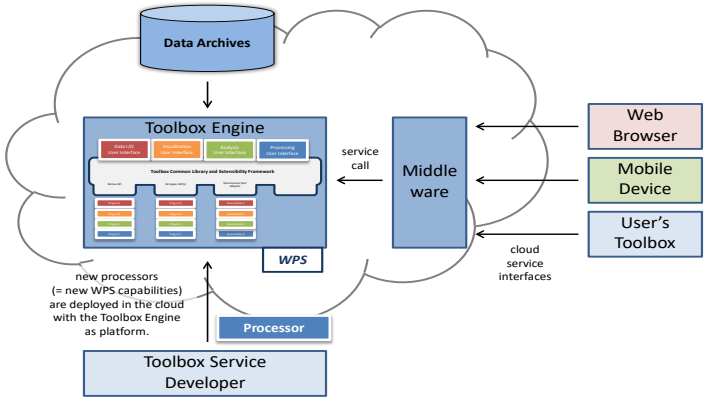
SNAP Cardinal Requirements

- CR 1 Openness
- CR 2 Multi-mission support
- CR 3 Extendibility & Modularity
- CR 4 Portability
- CR 5 Easy operability
- CR 6 Building on heritage
- CR 7 Performance

Benefits of SNAP

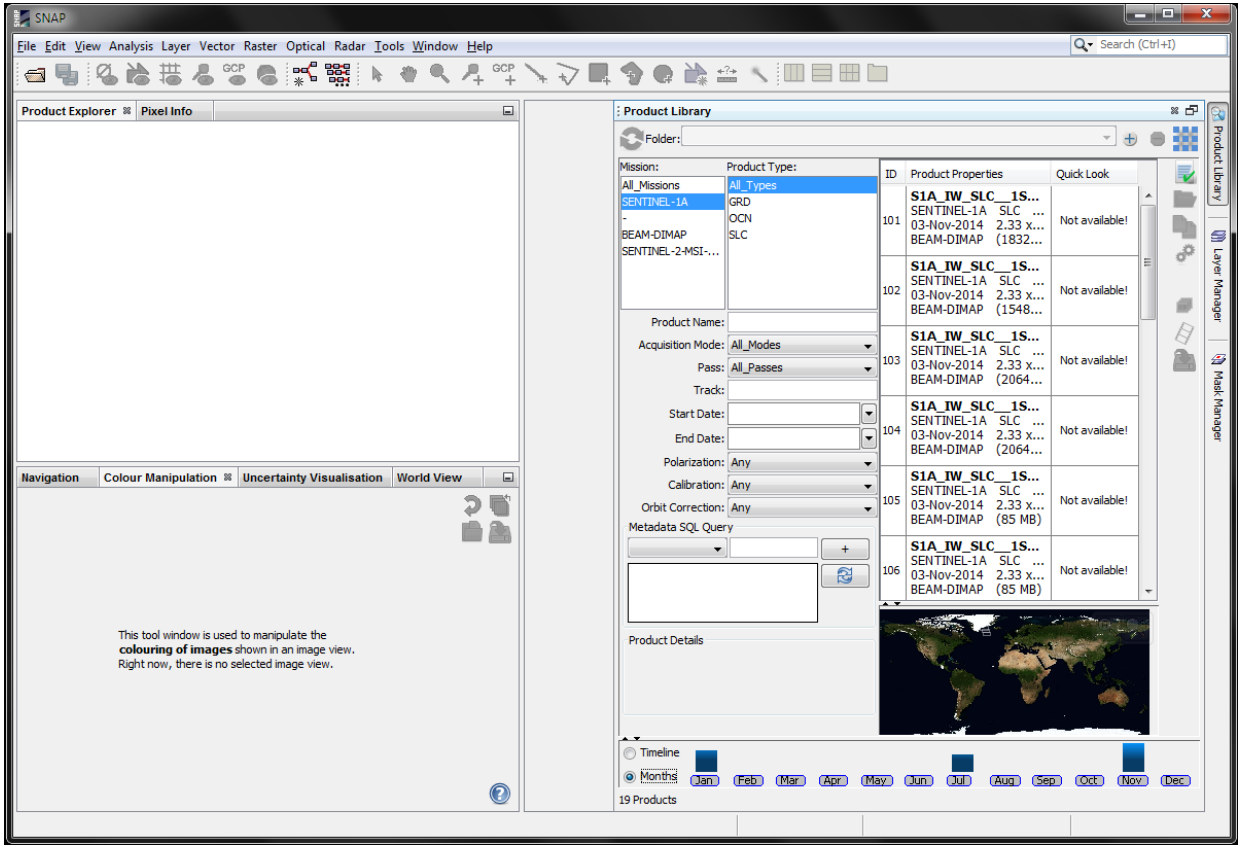
- Developed as open source software
- Common Java core framework
- Joint development plan for Sentinel toolboxes
- Interchangeable Java/Python plugins
- Portable engine to Cloud infrastructure
- Single installer

SNAP “Server Configuration”



SNAP

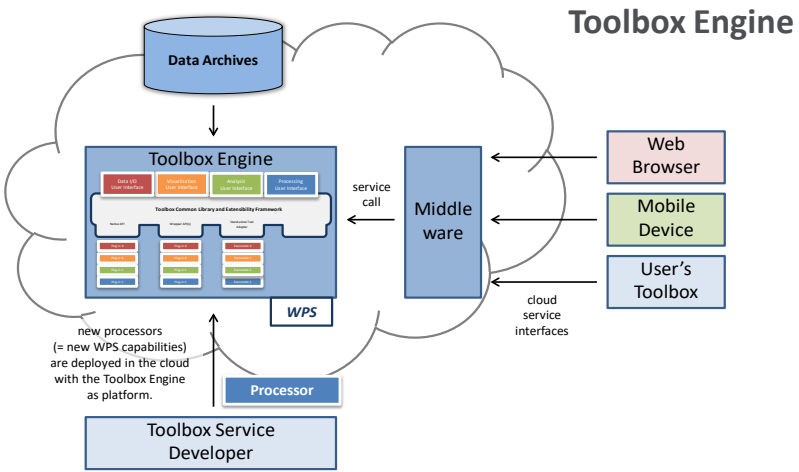
All-in-One Environment

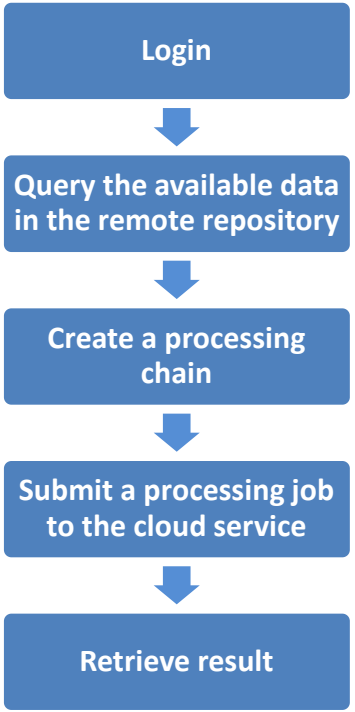


Cloud Exploitation Platform (CEP)

Smoothly utilize a ***Cloud Computing Platform*** where data repositories and high performance processing capabilities are available

Facilitate entry into ***Cloud Processing Services*** through the familiar and user friendly graphical interface of the Toolboxes

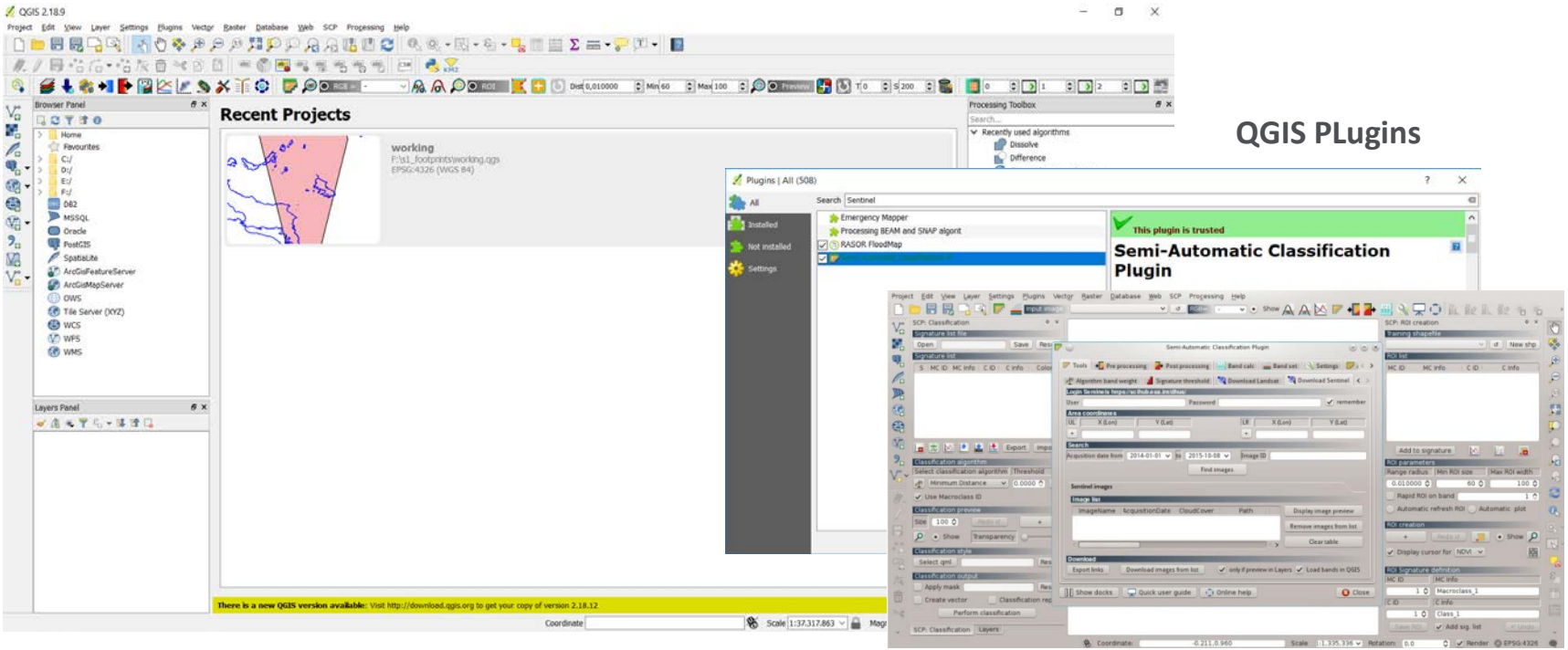




How to Measure Success

- The success of the Toolboxes can only be measured in terms of **user acceptance**.
- User acceptance is gained
  - if we provide the **tools that users need**;
  - if users **enjoy working with tools** we provide;
  - if we ensure that **these tools grow, improve and evolve** while they are being used;
  - if we **support and train the users** in using the tools;
  - if we **maintain the tools** and retain the efforts users already invested in understanding and applying the tools;
  - if we **let users participate** in a sustainable Toolbox development.

Third Party Sentinel Processing Tools | QGIS



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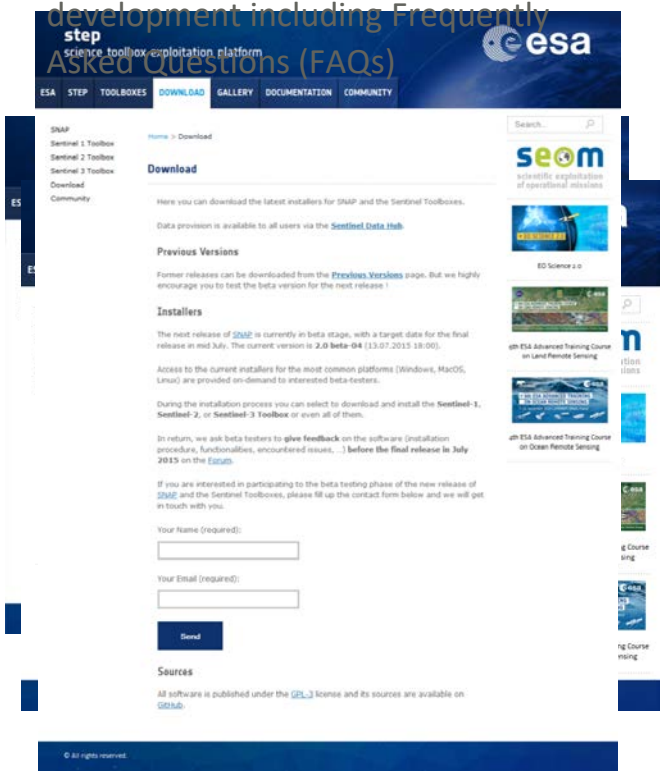
Science Toolbox Exploitation Platform

SNAP Download page

Information on Sentinel Toolboxes' development including Frequently Asked Questions (FAQs)

Access to Beta versions for testing



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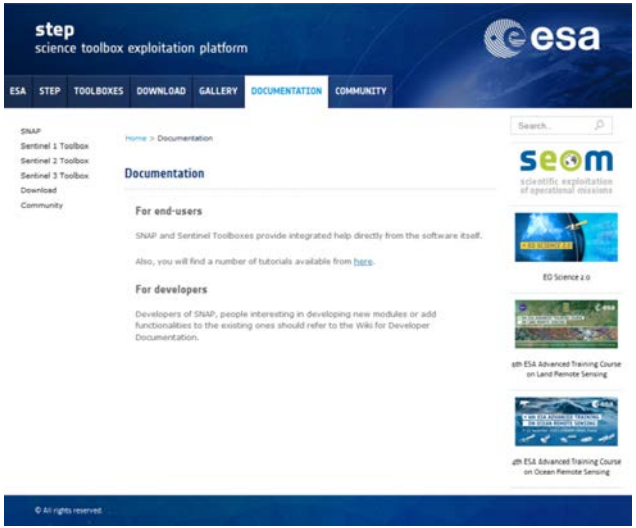
Science Toolbox Exploitation Platform

Technical documentation for both end-users and developers



step.esa.int

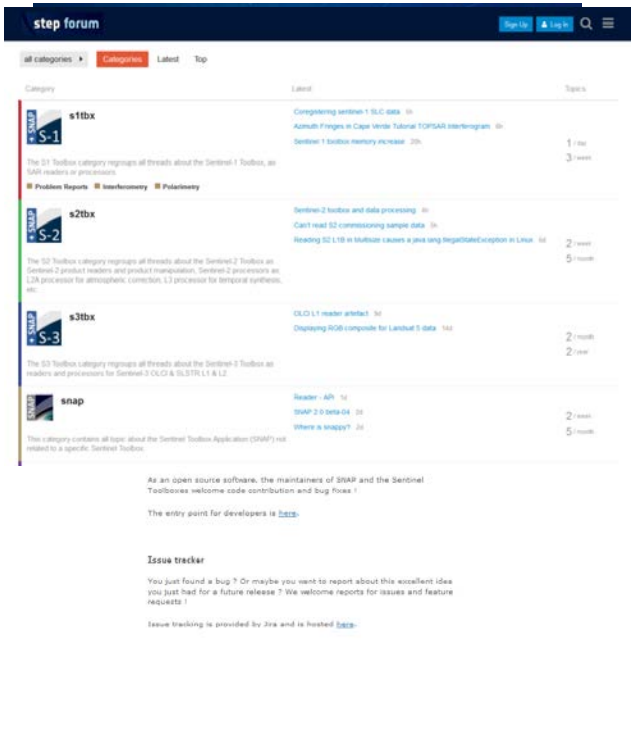
Science Toolbox Exploitation Platform

Step-by-step tutorials including YouTube videos

step.esa.int

Science Toolbox Exploitation Platform

Technical forum, gathering user feedback and communicating results



Thank you