

The background features a large, detailed silhouette of a satellite dish antenna in the foreground, set against a dark blue space background with a starry pattern. Several smaller, white line-art icons of various satellite configurations are scattered across the upper and right portions of the image. A faint, repeating pattern of binary code (0s and 1s) is visible in the background.

→ **SENTINELS COLLABORATIVE  
GROUND SEGMENT  
WORKSHOP #17**

**14–15 October 2019  
Executive Summary**



## BACKGROUND

The Copernicus Space Component has been established as one of the largest and most proficient Earth Observation infrastructure in the world. With seven high-performance satellites in orbit the system has evolved at a breath-taking pace.

Copernicus is the European Union's Earth Observation and Monitoring Programme, headed by the Commission (COM). The Commission is responsible for the overall initiative, setting requirements and managing the Copernicus services.

The Copernicus Space Component (CSC) – coordinated by ESA – includes the development and operations of the Sentinel satellites, as well as the distribution of the acquired Earth observation data. All Sentinel products are freely accessible online for the worldwide user community at [www.copernicus.eu](http://www.copernicus.eu) and [sentinels.copernicus.eu](http://sentinels.copernicus.eu).

In addition to that, and in close coordination with the Commission, ESA facilitates cooperation activities with Participating States contributing to the Copernicus Space Component Programme (including Canada), providing for direct and efficient access to Sentinel data. In the framework of the Sentinels Collaborative Ground Segment, potential activities of those countries are the set-up of a national mirror site, employment of their own local passive receiving stations, development of innovative data processing tools and applications and complementary calibration/validation activities. In any Participating State, various initiatives and entities can be involved in the cooperation. Therefore a National Point of Contact bundles the flow of information between the national entities and ESA.

Under the lead of the Commission, ESA implements a similar cooperation scheme also with further European countries and international partners.

## WORKSHOP CONTEXT

The Sentinels Collaborative Ground Segment (CollGS) workshops provide a platform for information and discussion between ESA, the National Points of Contact, national entities involved in the cooperation and COM. In order to foster coordination among the CollGS initiatives, workshops are organised by ESA at least once a year.

The objectives of workshop #17 were to:

- Report on the latest Copernicus Space Component (CSC) status and developments: programmatic and technical
- Update on the latest status of the various Collaborative initiatives established by the GMES Space Component (GSC) and Copernicus Participating States
- Promote the coherence between the CSC Ground Segment and Participating States collaborative initiatives
- Provide a forum for participants to harmonize their plans
- Address specific issues in the areas of:
  - Copernicus Data Access worldwide benchmarking
  - Copernicus Sentinels product traceability
  - Data Access and Information Service (DIAS) and Data Hub Relays (DHR) status
  - Collaborative GS evolution

The workshop took place on 14-15 October 2019 at ESA/ESRIN in Frascati, Italy. 51 external participants attended the workshop, representing 17 countries.

ESA, welcomed the workshop participants and introduced the workshop objectives. It was noted that continuation of the workshop in the current form is linked to decisions to be taken at the end of 2019.

ESA reported the overall operational status of the Copernicus programme, focusing on the main activities performed and evolutions made in 2019, access to new Sentinel products and missions and the current status of DIAS operations.

ESA provided an overview of the latest status and prospect of the Copernicus Space Component, including the overall technical implementation status and the status of the Sentinels missions and the Sentinel data access.

Individual presentations from ESA and Data Hub contractors then addressed specific topics in greater detail. These included the status and outlook of the Copernicus Sentinels Data Hub Service, Long Term Archiving activities, the Sentinel Data Dashboard, the Open Source Framework (OSF), worldwide benchmarking for Copernicus data access, the forthcoming Sentinels' Product Traceability Service, the DIAS and DHR status and Data Access user behaviour.

Interleaved with ESA presentations were 12 presentations from Member States and Copernicus Participating countries, addressing the progress of national CollGS initiatives.

## WORKSHOP HIGHLIGHTS

Participants continue to perceive the workshop as very useful to ensure coherence between the CSC development and national CollGS initiatives. Participants commented that the workshop should also facilitate an increase in the collaboration amongst member states and not only bilateral cooperation with ESA. The main highlights of the workshop are summarized below.

Following the completion of the Sentinel's family in orbit during 2018, this year has seen the completion of commissioning, followed by a period of routine operations and stability. Sentinel-1 is operating at close to full mission capacity. The Sentinel-1 High Level Operations Plan (HLOP) was updated to version 3 in July 2019, which will lead to a further optimization of the observation scenario. Further improvements of the Radial Surface Velocity components. Sentinel-2's yearly mission review was held in June 2019 and confirmed its excellent operational status. An

updated HLOP has been initiated in October 2019, with one of the impacts being that the cut-off of the winter observation angle in the Northern Hemisphere is now increased from 82 to 85 degrees latitude. A Level-2A on-demand service will be made available for Copernicus Services before the end of 2019, before being rolled out to all users. It is planned that a preliminary flow of selected Level-1B products will also be distributed on a rolling archive before the end of the year. The Copernicus DEM is now selected as WorldDEM and will be used for Level-1C and Level-2A production from 2020.

The commissioning of Sentinel-3B was completed in March 2019, following which the constellation has been fully operational. The HLOP v3 is still under discussion, but it is planned to increase twilight operations with on-going analysis to extend OLCI observations over Scandinavia in low sunlight angle conditions. Release of Aerosol Optical Depth (AOD) and Fire Radiative Power (FRP) prototype products is scheduled for Q4 2019. Snow and ice land products are being investigated. There is on-going improvement of the Level-1 and Level-2 processing baselines.

Concerning Sentinel-5P, a recent development was the TROPOMI operations change in August 2019 improving spatial resolution up to 5.5x3.5km (the original requirement was for 5.6x7.2km), resulting in 20% more science data. A Level 2 Processor upgrade is planned for early 2020 and will include algorithm improvements, for example for better use of surface reflectance in ozone NRT products. An Ozone Profile Product is planned for release in April 2020. Many further possible products are currently in the prototype development phase.

The status of Data Access operations and the Collaborative Hub was presented. In September 2019, the milestone of 20 million published products was reached, more than doubling the total number in less than one year. The increase was due to higher nominal production, with Sentinel-3A and -3B products now fully in operations, but also to the Sentinel-2 Level-2 global publication and Level-1 repackaging campaign. The Collaborative Hub continues to be run on three complementary nodes.

The total volume of downloads on the Collaborative Hub since the start of operations (as of this workshop) is 52.93 PiB, with 24.17 PiB of the total in the 10 months between December 2019 and September 2019. Issues addressed in 2019 included the management of database growth to cope with the rise in production, and addressing occasional poor download speeds. The latter appears to have been resolved with an upgraded proxy on the SciHub; the same solution is planned to be rolled out on the ColHub during October 2019.

New ColHub features include access to the full historic dataset of Sentinel products and the introduction of the Long Term Archive. The overall interest in of the CollGSs on products stored in the LTA has been calculated at around 0.3%. Whilst this makes sense considering that most CollGSs usually download products systematically, a potential issue might result from the occasional need for bulk downloads in the case of, for example, repopulations or specific applications (see discussion points below). It was noted that the allowed LTA quota on the ColHub is 20 requests per user per hour. Restoration performances since the start of LTA operations have been around 2 hours for Sentinel-1, 1 hour for Sentinel-2 and under 1 hour for Sentinel-3.

The status of the Data Hub Open Source software was presented. Version 2.0.0 was released in March 2019, with CollGSs amongst the notable users. Improvements in this version include a performance enhancement though database schema optimization and scalability, new product capabilities (including Sentinel-5P products and GNSS RINEX auxiliary files) and data flow improvements through a remote DHuS datastore and synchronizers.

The Copernicus Data Access Worldwide Benchmarking activity, foreseen during the last workshop, was initiated in February 2019. The activity is intended to investigate the varying performances experienced by users of the Data Hubs, which can depend on a number of variables including geographical location, user and network infrastructure, user needs etc. The benchmarking activities, based on an independent contract, will be based on measurability, comparability and reproducibility

of performances, providing a user Quality of Experience (QoE) measure. Up to 30 test sites around the globe, representing a statistical sample of the user base of Copernicus data access services, are being identified for full-scale installation and configuration of test tools. The next steps include the completion and validation of user scenarios and the consolidation of the test site calibration procedure and QoE parameters. A Service Operations Readiness Review is planned for January 2020.

Data lineage and provenance is of critical importance for Copernicus data; a Copernicus Sentinels Product Traceability Service is being planned to address this. The service has several objectives: to record product lifecycle events, to allow the retrieval of product history, to verify if a product copy is genuine and to enhance trust in processing chains. The service will operate within a context of exponential growth in available products due to growing numbers of satellites, increasing product types and levels and new processing chains, data providers and users. The general concepts behind the service were presented, including traces, hash functions, the certification process and digital signatures. The service will allow verification of a CollGS data collection with the ESA data collection and provide an independent record of what is available.

The status of the DIAS and Collaborative Relays was presented. The four DIASs have now been in operation for a little over a year, with the first yearly operations review held in June 2019. The services and data offered are maturing, with self-sustainability targeted as an objective for the 2020-2021 period. The services offered are also being benchmarked. Regarding the Relays, the point was made that the synchronization mechanisms addressed are still quite basic, without real load-balancing, it was highlighted that the service could be reinforced to better support CollGS mirror sites, also allowing retrieval of reference data from external sources. The DIAS could be integrated as a source of data for the network of relays, and could itself possibly host a relay.

ESA presented a study seeking to improve understanding users' behaviour regarding retrieval of new vs old products.

This involves looking at the probability that products will be requested according to product type, publication dates, mission, area of interest etc, and applying such information to the continued optimization of the data offer, offering potential for fine-tuning of the online access rolling window.

## NATIONAL COLLGS HIGHLIGHTS

Many national activities, in particular Sentinel data mirror sites, and generation of high-level products and services are operational. Provided services offer in some cases Sentinel data along with other mission data and hosted processing capacities. In particular, the following highlights were presented:

**Austria CollGS:** The national mirror site is operated by ZAMG and provides access to the global Sentinel archive; EODC also provides access to EO data archives accessible in a hosted processing infrastructure. Services have stabilized over the last year, following four years of experience in set-up and operations, including DHR operations from 2016. The gain in experience has been a significant enabler for Copernicus user uptake activities. Ongoing activities include federation with EODC and the WEKEO DIAS, as well as the European Open Science Cloud (EOSC), and the implementation of the Austria Datacube for value added Sentinel-1 and Sentinel-2 products. Continuation of CollGS activities in the next period is now explicitly supported with the next mid-term goals including the joint development of value added services and the continued move towards federation with other providers.

**Belgium CollGS:** Since the agreement signed between ESA and BELSPO in September 2017, VITO (the designated entity for the CollGS) has released the website in December 2017 and, in March 2018, Terrascope, the Belgium platform to access and use Copernicus Data. The platform includes the Terraviewer, an EO browser, and the focus has been on easy access for users and support for APIs. Products from Sentinels -1, -2, -3 and -5P, Proba-V, Vegetation and the Copernicus Global Land Service are supported. Web services provided include time series queries, WMTS, WMS, WCS and OpenEO API, with Jupyter notebooks and preconfigured virtual machines provided for expert users.

Funding has been secured until mid-2023, with the next development goals including Sentinel-1 subsidence maps, the addition of Sentinel-3 VGT and Sentinel-5P products and the production of cloud-optimized GEOTIFFs.

**Canada CollGS:** The Canadian Archive (EODMS) is largely focused on Canadian missions, though does mirror some Sentinel data. Launched in October 2018, it currently holds over 1 million archived images from approximately 20 mission, comprising of radar data (including RCM), optical, long term satellite data records, and images from the National Air Photo Library. Services provided include spatial search, APIs (CSW, WCS, OpenSearch), near-real time downloads and order management including standing orders and pre-processing. In terms of Copernicus Data, Environment Canada are using Sentinel-1 GRDM products for researching Arctic sea ice dynamics and melt processes. Fast retrieval is critical for the timeliness of the analysis and ice motion products generated.

**Czech CollGS:** The Czech CollGS is managed by the Ministry of Transport and developed and operated by CESNET. A National Mirror has been available since late 2016 and a DataHub Relay (DHR) since spring 2018. There are currently 163 registered users on the National Mirror, and over 200,000 product downloads, mostly in the land and agriculture domains. It is noted that time series prove more attractive than rapid access to data. Improvements over the last period include the externalisation of databases following the move to DHuS 2.0 in July 2019, which has led to an extreme reduction in query times and improved relay performances.

**France CollGS:** The PEPS mirror site platform was opened in September 2015 and now has nearly 5500 registered users. It offers three main functions: a mirror site for Sentinels-1 and -2 data products (with global coverage and from the start of operations), processing tools allowing 'first level' treatments, results visualisation and product downloading functions, and access to high performance near data resources with user support. During 2019, system saturation of both bandwidth and storage resulted in the redefinition of the PEPS 'perimeter':

download of Sentinel-3 products was terminated due to very few users, followed by Sentinel-2 L2A products, as on demand atmospheric correction processing is already available on the platform. An increase of storage and processing capacities to >16 PB is planned by the end of 2019, as well as a 'data lake' infrastructure (40 PB) additionally used for SPOT, Pleiades and altimetry products. Online processing tools now include multi-date processing, orthorectification of Sentinel-1 products vs the Sentinel-2 grid, Sentinel-2 ground reflectance using MAJA, Sentinel-2 image correlation and Sentinel-1 interferometry. It was noted that PEPS supports large amounts of data access and reprocessing of 'older' products, reflecting the fact the most users are scientific and require historical access.

**Germany CollGS:** The CODE-DE data and exploitation platform has been operational for data access since March 2017, offering open view and discovery services, as well as download following self-registration, with the focus on national public service institutions. All Sentinel data is stored: For Sentinel-1/2 on a global level for 10 days, on a European level for 20 days and over Germany for the entire period. Sentinel 3 and 5P data are stored longer, 1 month globally and 12 month for Europe. Sentinel-1 products are also provided by the Direct Downlink Mode from the local station at Neustrelitz. The current service will be provided until End of March 2020, with a finalized tender process for Phase 2 and a CODE-DE provision until October 2024. The next generation platform will be hosted in Frankfurt and will mirror all national Sentinel data products as provided by ESA and will synergistically use the CREODIAS infrastructure including other imagery such as those from Landsat 5/7/8.

**Greece CollGS:** The Hellenic Sentinel data mirror synchronizes products from the Collaborative Hub for an AOI which covers the Mediterranean and Black Sea and surrounding lands with a 25-day rolling archive. 500 TB of products have been published in the last 12 months. During the last year, 91 users have registered, bringing the total to 678, with 70% of users from the research community and most data used for atmospheric and land applications. The Hellenic Mirror site is also linked

with the European Open Science Cloud (EOSC). Developments during 2019 include an 'umbrella' application which attempts to solve the data fragmentation issues imposed by 23 different CollGSs, each with different data offers, through linking the Hubs in a federated manner.

**Luxembourg CollGS:** The LSA Data Center is the Luxembourg entry point for products from Sentinel missions. The goal is to accelerate the development of downstream value-added applications and services. Developments were initiated in January 2018, with the Center operational from November 2018 and open to the public from May 2019. Full repatriation of the Sentinel-2 archive was achieved in January 2019, with the ongoing repatriation of Sentinel-1 products initiated in May 2019. The Data Center does not currently operate a rolling policy and all products are available online to authenticated users.

**Netherlands CollGS:** While no dedicated CollGS has yet been established, the current 'Pre-Copernicus' Satellite Data Portal has been available since 2012, offering basic view access and HTTP / FTP access to users based in the Netherlands from a portfolio of pre-Sentinel-1 radar data and high resolution optical data. The Technology Roadmap for Ground Segment Data Processing has recently undergone a revision to version 3, examining how best to serve users and the use of DIAS. Possible identified ways forward include the extension of the Satellite Data Portal with a national gateway to a Network of Resources, or public-private (cloud agnostic) CollGS, either inside or outside DIAS, and/or within the national scientific infrastructure. A dedicated Mission Exploitation Platform (MEP) is also a possible way for higher-level Sentinel-5P products.

**Norway CollGS:** The Norwegian Collaborative Ground Segment aims to simplify access to Copernicus Sentinel data, ensure support for national services and preserve data for the Norwegian AOI. Sentinel data is retrieved from ESA's Collaborative Hub, EDRS and direct Sentinel-1 reception facilities at Svalbard, Tromso and Puertollano. Data is distributed to users via two portals: colhub.met.no and satellittdata.no: the former runs the

DHuS software suite and serves operational needs while the latter is an open data space, converting Sentinel data from SAFE to NetCDF/CF in order to facilitate the integration of non EO data, such as meteorological/oceanographical products and in-situ observations. Current services on satellittdata.no include an interactive mosaic tool, a Sentinel-2 comparison tool, a transformation (subsetting, reprojection, reformatting) service, visualisation and co-visualisation of Sentinel-1 and Sentinel-2 images, and a Sentinel acquisition plan tool covering Norwegian AOI. Planned developments include provisions of orthorectified Sentinel-1 products and Sentinel-3 and -5P products in NetCDF/CF format. The principal users of data from the CollGS include EMSA QRT services, the Norwegian Coast Guard (now with automatic interpretation of all QRT images) and commercial services in oil and gas, defence, research and fishing. InSAR Norway was opened in November 2018, using Sentinel-1 data to provide operational subsidence data production over Norway. A new launch is planned for January 2020, adding Radarsat products and Sentinel-1 data from 2019 with an API release. A service covering sea-level changes and flooding is also being investigated.

**Poland CollGS:** The Polish initiative within the Collaborative Ground Segment, “Operating system for gathering, sharing and promotion of digital information about the environment - Sat4Envi”, is managed, developed and operated by the consortium of the Institute of Meteorology and Water Management (IMWM), the Crisis Information Centre (CIC) at Space Research Centre of the Polish Academy of Sciences, the Polish Space Agency (POLSA) and Academic Computer Centre CYFRONET at AGH University of Science and Technology. It is adopting a need-based approach and user-orientated perspective. Dedicated trainings for public administration are very important part of the project. Sat4Envi development is currently progressing in three stages: stage 1 involves the accumulation of satellite data on a disc array; stage 2 concerns the archive integration and development of the Customer Service System; stage 3 will provide full online access to the

data. Users will differ with their scope of the access: ‘advanced users’ will have an access to the whole archive, generally for scientific purposes, and ‘priority users’ will be provided with fast access to data, for example for crisis management. Customer Service System will host data covering Poland and the Baltic Sea and will be fully operational by autumn 2020. Sat4Envi is co-funded by the EU funds.

**Romania CollGS:** A Romanian mirror site has been set up based on the agreement with ESA. The goal is to provide reliable and sustained access to, and tools for the exploitation of, satellite and in-situ data. The site provides access to products from all Sentinel missions, with a rolling archive of one month and an AOI initially covering Romanian territory and later to be extended to cover the entire Danube basin. It is intended to be a central point of access to organisations requiring bulk downloads (e.g. Meteo Romania), universities and R&D organizations. The identified way forward includes upgrade of new hardware, the continued development of thematic portals providing specific information (e.g. for crisis management), the consideration of datacube technologies, the initiation of collaborative activities in particular with regional actors, and the continued raising of awareness on the services offered.

**UK CollGS:** The current UK CollGS includes SeDAS, operated by Catapult and serving commercial and other users, and CEDA-JASMIN, operated by STFC-RAL and providing academic data access. SeDAS user base has increased to ~100 users. It is now also supporting Space for Smarter Government Programme: 3 years’ worth of imagery covering Great Britain and Northern Ireland, including a significant proportion of the shoreline at less than 5m per pixel resolution. SEDAS’ new Python API has been downloaded 300+ times since launch in September 2019. SeDAS is accessed at <https://geobrowser.satapps.org/>. JASMIN currently mirrors data from all Sentinel missions; with priority towards global Sentinel-3 SLSTR (including reprocessing) and SRAL; global Sentinel-5P; and global Sentinel-1, UK coverage for Sentinel-2. JASMIN now supports around 200 active projects through group workspaces, compute, virtual machines.

New datasets continue to be added and are detailed at:

<http://archive.ceda.ac.uk>

## WORKSHOP DISCUSSION POINTS AND RECOMMENDATIONS

In general, it was considered that data access for CollIGSs works well at present. DHRs are also considered useful, with a high volume of data being exchanged through them. Data access will be secure and guaranteed and evolutions will be carefully monitored. The Collaborative Ground Segment is considered as a framework to share technology and prototypes and ESA intends to continue in this direction.

The participants considered the workshop a useful platform to share experiences and exchange ideas, with the exchange currently working well for both sides. A number of common topics and themes were addressed, in some cases leading to recommendations being made. These included:

- Several points were raised on the Long Term Archive. In particular, there were concerns that the current retrieval time (usually several hours) coupled with the limits of the quota would impose severe constraints on CollIGSs needing to repopulate archives or requiring large amounts of archived data for specific applications. In general, the current LTA offers no dedicated handling of bulk requests and the applied quota can result in large numbers of retrieval requests being rejected. While a guaranteed short retrieval time (e.g. 10 minutes) for all products would require a fully online service, this is not considered an efficient long term solution, with analysis of user behaviour suggesting that around 80% of products are only rarely accessed after the 6 month mark. ESA will continue to monitor user behaviour in this regard, as well as investigate how bulk requests for specific applications from CollIGSs can better be planned, with an automatic logic applied to such retrievals if possible. Related to this, it should be explored how to

redirect user requests to other sources (e.g. other CollIGSs or DIASs) in cases where requested products are not directly available from the Copernicus Hubs, for example through the promotion of coordination between CollIGSs. ESA will discuss these issues with the Commission and possibly organise a dedicated forum, with CollIGS participation, to collect overall requirements and coordinate how to retrieve large amounts of rolled-out data.

- Several participants stressed the benefit of coordination between CollIGS providers, stating that support provided by other providers has been instrumental to the success of their own services and that the need to facilitate communication is ongoing for e.g. sharing of scripts, software and solutions. ESA should continue to promote such discussions, as well as visibility of the various CollIGSs, and initiate debate on a future federation of resource providers.
- Concerning the provision of CollIGS statistics on the Sentinel Data Dashboard, last year's proposal to include dynamic, daily statistics via a JSON file did not receive particularly strong backing or take-up. A new proposal is to include year summary statistics already provided via the annual CollIGS questionnaires. If partners do not wish such information published on the dashboard, they would be able to indicate this.
- Following the introduction of the forthcoming Product Traceability Service, it was discussed how much legal weight such a service would offer, for example concerning earth observation data used in court. ESA commented that such legal implications have not yet been investigated in detail.
- Even before the full availability of the Traceability Service it is recognised that CollIGS operators have a need to remove or update products identified as faulty, incomplete, republished or repackaged. Human readable announcements are not in themselves sufficient to manage the curation activities. ESA do provide an automated mechanism to advertise such products that may not be sufficiently familiar with all CollIGS.



- It was generally agreed that, ideally, the final packaging of downloaded products should be the choice of the requesting user. There is ongoing discussion as to how to ease the conversion between packages and recommendations will be made.
- A discussion was held on the impact and use of the DIAS in the CollGS context. The question was raised as to whether all DIASs will eventually have all Copernicus data available. ESA responded that all offer the complete catalogue, though full local archiving was not required and some opted for partial archiving and relaying. Recently, however, there have been moves back towards making all data available locally, under the relevant DIASs' own initiative. In addition, there is an issue concerning packaging of data, with some DIASs packing/unpacking solutions resulting in differences in volumes and problems with traceability. ESA responded that this is one of the reasons the Traceability Service is being initiated, but stressed that the DIAS, unlike the Data Hubs, is not a part of Copernicus core operations: the Data Hubs and the DIAS should be considered separate.
- It was confirmed that use of the Copernicus DEM will be free and open to all at the 90m (global) resolution. For the 30m (also global) and 10m (EEA39 only) resolutions, access will be restricted. The question was raised as to whether CollGSs will have access to the restricted DEMs. It would be necessary, for example, where Sentinel-1 products need to be mapped to those of Sentinel-2. ESA responded that there is still much legal and administrative work to be done on this issue and the answer should become clearer in the coming months.

It was re-iterated that ESA cannot currently commit to the format of future exchanges with the CollGS community, as this will depend on decisions to be made by the end of 2019. However, the Agency stressed its continued support for CollGS activities if funding is available and confirms that plans are being prepared to reduce any interruptions as far as possible. A further meeting should be organized for next year, as well as possible specific technical discussion on issues including traceability, benchmarking and relays. Thereby ESA, in close coordination with the Commission, will follow up the recommendations made in the workshop and report on their status as appropriate.