D5.5 Blueprint, business and sustainability plan V2

Status:	Under EC Review	**Planned due date:**	31/03/2023
Version:	1.0	**Submission date:**	04/07/2023
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Related WP:	WP5	**Document Ref:**	D5.5
Dissemination Level:	Public (PU)		
Document Link:	https://doi.org/10.5281/zenodo.8109295		

Deliverable Abstract

This document provides the final report on the services created in the C-SCALE project aimed to streamline data coming from Copernicus platforms and EOSC e-infrastructure compute providers. The report includes a description of the key exploitable results and the main services created during C-SCALE to ensure their exploitation, uptake and sustainability beyond the life of the project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017529.

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DOCUMENT LOG

Issue	Date	Comment	Author(s)
V0.1	29/03/2023	Deliverable document was created	XS, SLV
V0.2	12/06/2023	Draft ready for internal review	XS, SLV, EF, BB, ZS, CC
V0.3	30/06/2023	Added reviewers' comments	XS
V1.0	30/06/2023	AMB approved deliverable document ready for submission	XS

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List of Acronyms

Acronym	Description
AAI	Authentication and authorization infrastructure
AMB	Activity Management Board
API	Application Programming Interface
C-SCALE	Copernicus – eoSC AnaLytics Engine
DIAS	Data and Information Access Services
EAP	Early Adopter Programme
EO	Earth Observation
EOSC	European Open Science Cloud
GOCDB	Grid Configuration Database
HPC	High-Performance Computing
HTC	High-Throughput Computing
OIDC	OpenID Connect
SRAM	SURF Research Access Management
STAC	SpatioTemporal Asset Catalog
TRL	Technology Readiness Level
VA	Virtual Access
WP	Work Package

Executive Summary

The C-SCALE Project Blueprint, Business and Sustainability Plan v2.0 presents the follow-up definition of the technical blueprint described in D5.4. It provides a methodology for capturing the related Key Exploitable Results of the project, expands on the services created along the C-SCALE compute and data federation providing a detailed blueprint for each of them and the different activities and outcomes to ensure the exploitation and sustainability of the project results has been described.

Five Key Exploitable Results have been described:

- Federated Earth System Simulation and Data Processing Platform (FedEarthData)
- Earth Observation Metadata Query Service (EO-MQS)
- openEO Platform
- Workflow solutions
- C-SCALE Support

Blueprints for the FedEarthData, EO-MQS and openEO Platform have been provided - including the definition of roles and responsibilities and main service management elements necessary for the delivery of the services, the onboarding of new providers and the support generated.

Exploitation opportunities and plans for each of the results have been identified - including the generation of three services, one set of products (workflows) and one to cover the generated support material - which can be used in further research initiatives or commercial settings. Also, standardisation has been sought by aligning the technologies used into widely used standards (such as STAC-data) or well-established tools (such as Slurm or OpenStack)

Sustainability of the results is granted as services are backed by Letters of Commitment from the providers and will keep operating under the control of their well-defined owners (FedEarthData, EO-MQS, openEO platform). Those have been incorporated into the service portfolio of their owners (EGI and EODC). Workflows & Support material will be made available under open-source permissive licences to facilitate and foster their use/re-use. Improvements to already existing services have been introduced thanks to the contributions done to the project (such as EGI Check-in, SURF SRAM, INFN PaaS orchestrator). Streamlining the access to Copernicus data (e.g., via EGI Notebooks, openEO) has also contributed to the increase of users of EGI compute services within the EO community. On top of this, all know-how generated is already being reused in further projects and has been capitalised on along with the project partners.

The project has delivered a significant impact in terms of scientific advances, economic wealth and societal improvements - given the relevance of the use cases of the project and is in the right position to keep on contributing to the future initiatives promoted by the European Commission beyond EOSC such as Destination Earth and its related Digital Twins, Data Spaces, etc.

1 Introduction

This deliverable is a follow-up deliverable from D5.4 Blueprint, business and sustainability plan v1 which provided an overview of the blueprint, engagement model, and joining procedures for the C-SCALE federation, demonstrating its potential for facilitating large-scale research, promoting collaboration, and driving innovation in Earth Observation-based activities enabled by European Open Science Cloud (EOSC) and beyond.

C-SCALE focuses on creating a federated data and compute environment for large-scale research using Copernicus and related Earth Observation (EO) data. The deliverable outlines the goals, strategies, and benefits of the C-SCALE federation, including the accessibility of a long-term data archive, facilitation of open and repeatable research, and integration of cross-disciplinary EOSC services.

The C-SCALE federation aims to attract providers to join and expand its distributed setup by adopting simple and commonly used technologies, such as Slurm for HTC/HPC, OpenStack for Cloud providers, openEO or Jupyter Notebooks as user environments to lower the access barrier to Copernicus data. This will enable wider use and inclusion of neighbouring research domains and promote cross-pollination of services and resources between research communities. The establishment of the C-SCALE federation and validation through relevant use cases are key objectives, which will lead to the creation of new research services and enrich the EOSC service offer.

D5.4 deliverable outlined the initial technical blueprint for the C-SCALE federation which includes Compute and Data Federation.

- The C-SCALE Compute Federation aims to deliver access to a distributed infrastructure to support data- and compute-intensive workloads, offering cloud and HPC/HTC resources depending on the user's needs.
- The C-SCALE Data Federation focuses on bringing together Copernicus data providers from different ecosystems and aims to provide a single interface for querying and a unified procedure for accessing datasets.

Basic procedures for joining both the C-SCALE Data Federation and the C-SCALE Compute Federation were presented as part of D5.4. It included the requirements and steps for providers to expose their interfaces and endpoints, enable federated authentication, and register their services in relevant configuration databases. It also highlights the interoperability between the Data and Compute federations, that enable seamless interaction for users and automated workflows and how those have been tested and validated in several use cases. The basic figure for the C-SCALE federation workflow is kept here below for a better understanding of this deliverable.

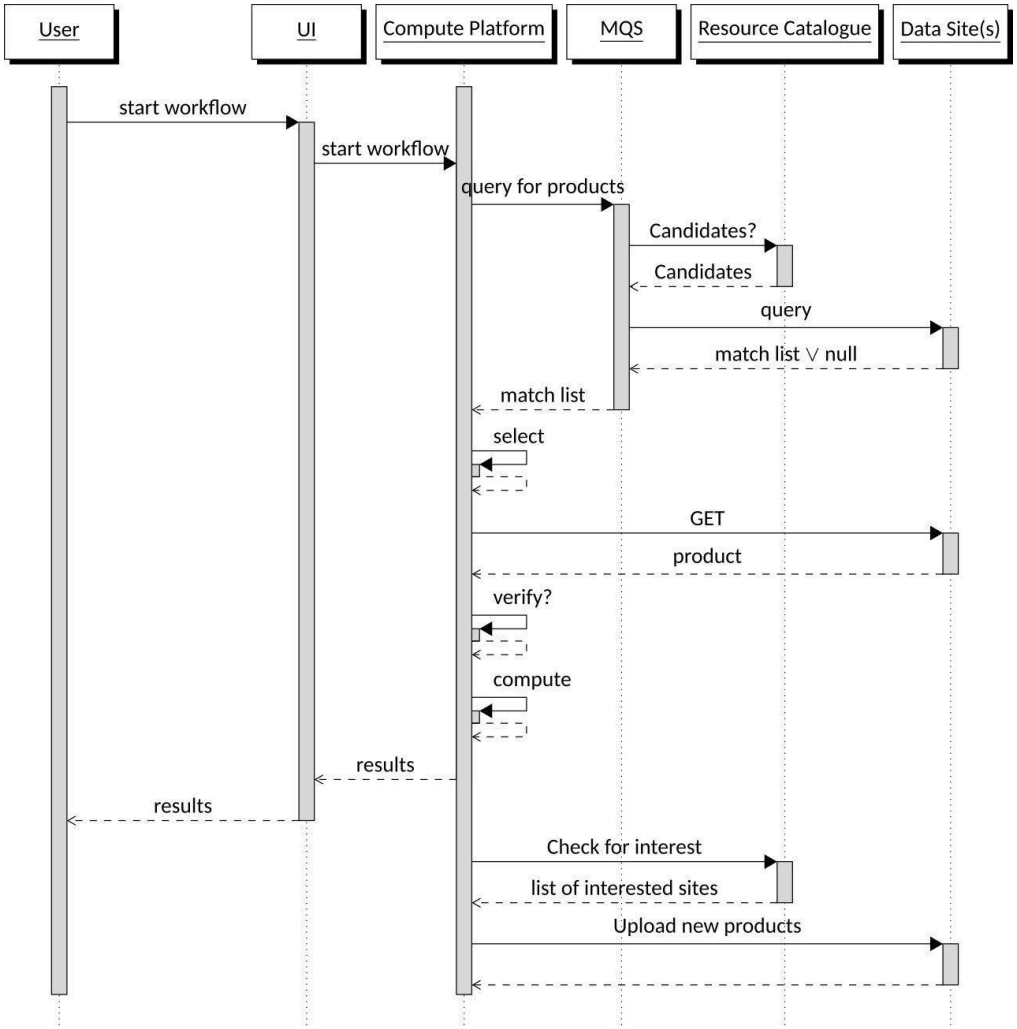


Figure 1: C-SCALE Federation workflow (ref. D5.4)

This deliverable D5.5 builds from D5.4 Blueprint, business, and sustainability plan v1 to expand the C-SCALE Compute and Data Federation. It focuses on the Key Exploitable Results that describe the different services that have been created around the C-SCALE Federation, the set of workflows and software that have been developed for the initially defined use cases, and the related support and training material that has been generated during the project. A specific user blueprint has been generated for each of the services, in order to complement the technical blueprint of the C-SCALE Federation, describing the main flow of the services. Main exploitation plans and activities are presented and the deliverable finishes with a discussion on how these contribute to the longer-term sustainability of the C-SCALE generated service offering within the European Open Science Cloud (EOSC) and beyond and how this will contribute to the evolving EO landscape within Europe.

2 Methodology

In order to ensure the effective exploitation of the project results and ensure those are delivering the most impact following framework has been described - in which Key Exploitable Results have been collected and described, a detailed service blueprint is provided, and for each of them Exploitation, Sustainability and Impact are assessed.

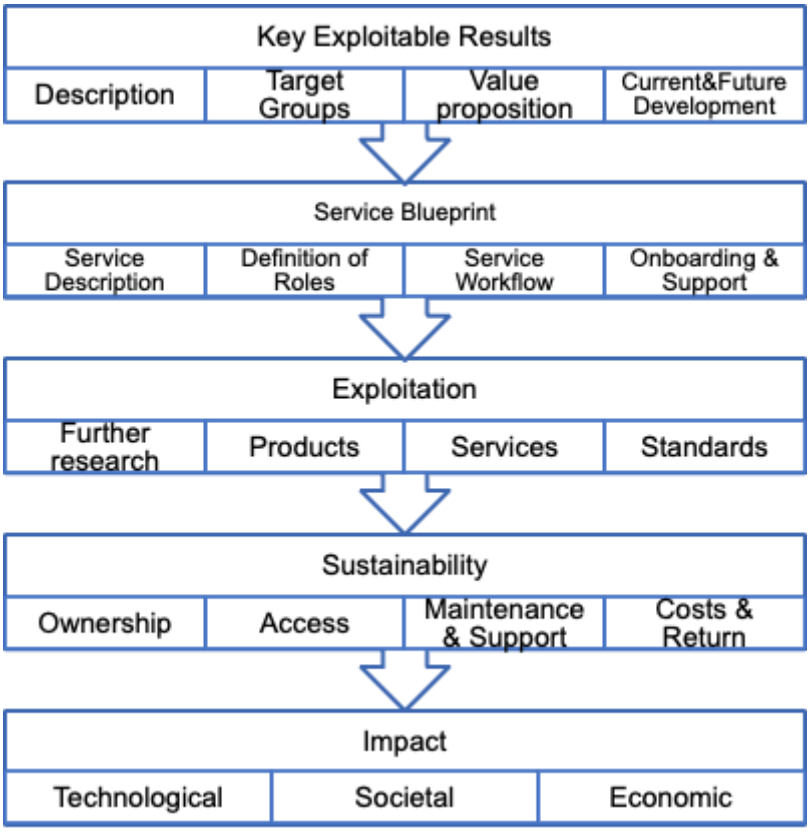


Figure 2: Methodological framework for D5.5.

2.1 Key Exploitable Result (KER)

A **Key Exploitable Result (KER)** is an identified main interesting result (as defined above) which has been selected and prioritised due to its high potential to be "exploited" – meaning to make use and derive benefits- downstream the value chain of a product, process or solution, or act as an important input to policy, further research or education.

Selection of KERs was specifically, based on the a) degree of innovation, b) exploitability and c) impact of the project results, an initial list of KERs was suggested by the Innovation Management team within WP5 and discussed within the Activity Management Board of the project. The list of KERs was later presented and approved by the General Assembly in a physical meeting and a project member was assigned to each one of them as a KER Champion. Each champion has been responsible

for maintaining – in collaboration with the Innovation Manager – the overview of the KER throughout the duration of the project and during the second half of the project to expand all the information related to exploitation, sustainability and impact.

On top of the KER descriptions, for each of them, the main target groups and stakeholders, Value Proposition, and the Main developments done during the C-SCALE project and the future work. This information is in line with the required information for including the KERs in the Horizon Platform[1]:

KER Owner: The KER Owner refers to the institutions or entities that have legal or intellectual property rights over the result. It is important to specify the ownership information, which could be an individual researcher, a research institution, a company, or a jointly owned result of the consortium. This information helps establish the authority and responsibility for the KER and is a key aspect for ensuring the exploitation and sustainability of the KER.

Target Groups: Target Groups are the specific audiences or stakeholders for whom the KER is intended. It has been separated between target user groups or beneficiaries who would benefit from the result (e.g., researchers, industry professionals, policymakers, or the general public, etc) with the actual target audiences & interest groups described in the Horizon Platform.

Value Proposition: The value proposition explains the unique value or benefits that the KER offers to its users, customers or target groups. It focuses on the advantages, and main benefits that the KER brings, over existing assets.

Current & Future Development: This aspect provides an overview of the actual developments that have been completed during the project and any planned future developments, enhancements, updates, or iterations of the KER.

TRL Level: TRL stands for Technology Readiness Level and is a measure of the maturity of a technology or innovation. According to European Commission[2] following are the different levels:

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified

[1] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform

[2] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

The TRL Level indicates the stage of development the KER has reached, ranging from early concept stages to fully validated and commercially deployable. Specifying the TRL Level is crucial for the later onboarding of the results to the EOSC marketplace, among others.

2.2 Service Definition and Blueprints

A service blueprint refers to a visual representation or diagram that outlines the various stages, components, and interactions involved in delivering a service to users or customers. It provides a detailed and holistic view of the service journey, highlighting both the front-end customer experience and the underlying processes and resources required for service delivery. A service blueprint typically includes information such as customer touchpoints, service steps, support systems, and potential interactions between customers, service delivery team, and technology. It helps the project understand and design the service experience and ensure consistency and quality in service delivery.

Service Description: The service description provides a further overview and clear understanding of the service being offered. It outlines the main features, benefits, and value proposition of the service. This description helps both the service provider and the customers to have a shared understanding of what the service entails.

Definition of Roles: This element defines the specific roles and responsibilities of individuals or groups involved in delivering the service. It identifies who is responsible for various tasks and interactions within the service workflow. By clarifying roles, it ensures that everyone involved understands their responsibilities and contributes effectively to the service delivery process.

Service Workflow: The service workflow depicts the sequence of steps and interactions involved in delivering the service. It outlines the entire service journey, from the initial contact or request to the final fulfilment or resolution. This visual representation ensures a smooth and efficient experience for customers or users.

Onboarding & Support: This element focuses on the process of onboarding users or infrastructure providers and the necessary support throughout their service journey. It ensures that customers or users have a seamless transition into using the service and have access to the necessary resources and support channels for a positive experience.

2.3 Exploitation

According to the Grant Agreement, beneficiaries must *take measures aiming to ensure the 'exploitation' of its results (either directly or indirectly) in particular through transfer or licensing by:*

(a) using them in further research activities (outside the action);

(b) developing, creating or marketing a product or process;

(c) creating and providing a service, or

(d) using them in standardisation activities.

Further research activities (outside the action): Beneficiaries should aim to utilize the project results as a foundation for further research beyond the current project. This could involve activities such as:

- Publishing research papers or academic articles based on the project outcomes.
- Presenting the findings at conferences, workshops, or seminars to disseminate knowledge and engage with the scientific community.
- Collaborating with other research institutions or experts to expand on the project's findings.
- Incorporating the results into new research proposals or projects, building upon the knowledge and insights gained during the current project.

Product Creation: Beneficiaries should explore opportunities to transform the project results into tangible products, processes, or innovations. Some examples of activities include:

- Developing a prototype or proof of concept based on the project's findings, which can be further refined for commercialization.
- Securing intellectual property rights (IPR) for inventions or innovations emerging from the project and pursuing patent applications.
- Collaborating with industry partners to translate the research outcomes into marketable products or processes.
- Conducting market research and feasibility studies to assess the commercial viability of the project results.
- Establishing spin-off companies or startups to bring the developed products or processes to the market.

Creating and providing a service: Beneficiaries should consider how the project results can be transformed into valuable services for end-users or customers. Some examples of activities include:

- Offering consulting or advisory services based on the expertise and knowledge gained from the project.
- Developing software tools or platforms that provide specialised services or solutions to address specific user needs.
- Providing training programs or workshops to transfer knowledge and skills related to the project results.
- Collaborating with relevant stakeholders to establish service-oriented partnerships or consortia.
- Conducting user surveys or engagement activities to understand the needs and requirements of potential service users.

Using them in standardisation activities: Beneficiaries should actively contribute to standardisation efforts by using the project results to influence or shape industry or domain-specific standards. Some examples of activities include:

- Participating in standardisation committees or working groups related to the project's domain.
- Sharing the project outcomes and research findings with standardisation bodies for consideration in the development of new standards.
- Collaborating with industry partners to establish best practices and guidelines based on the project's results.
- Contributing to the development of technical specifications or protocols that improve interoperability or ensure compatibility within a specific field.
- Providing input and feedback on draft standards or participating in public consultations related to relevant standardisation activities.

2.4 Sustainability

Sustainability stands for those activities that ensure the uptake of C-SCALE results after the end of the project (or in different project contexts). Some important aspects to ensure sustainability are having clear ownership, access, maintenance and support, costs and expected returns (if necessary).

Ownership: Ownership refers to the identification of the entity or entities that have legal or intellectual property rights over the KER. It is important to establish clear ownership to define the rights, responsibilities, and control over the result. This ensures that the KER is protected and managed appropriately and that the owner(s) have the authority to make decisions regarding its use, dissemination, and further development.

Access: Access refers to the availability and accessibility of the KER to relevant stakeholders, such as researchers, service providers, or user communities. Ensuring access involves establishing mechanisms or policies that enable authorised individuals or organisations to utilise the KER effectively. This can include defining access rights, licensing terms, and technical infrastructure to facilitate the sharing and dissemination of the result.

Maintenance and Support: Maintenance and support involve activities aimed at preserving the functionality, reliability, and usability of the KER over time. This includes regular updates, bug fixes, improvements, and user support services. It is important to establish mechanisms to address any potential issues or challenges that may arise during the use and deployment of the KER. Adequate maintenance and support ensure the continued availability and usefulness of the result.

Costs: Costs refer to the financial considerations associated with the development, deployment, and ongoing sustainability of the KER. This includes the investment required for its creation, maintenance, and support activities. It is crucial to assess the costs involved and establish sustainable funding models to cover expenses, whether through grants, subscriptions, licences, or other revenue streams. Managing costs effectively ensures the long-term viability of the KER.

Expected Returns: Expected returns relate to the benefits or value that stakeholders anticipate deriving from the KER. This can include scientific, economic, societal, or environmental impacts. Assessing the expected returns helps justify the investment in the KER and provides a basis for decision-making regarding its sustainability. It is important to evaluate and communicate the

potential returns to attract stakeholders, foster collaborations, and secure ongoing support and resources.

In summary, these aspects help establish a framework for managing and advancing the results beyond the project duration, ensuring its long-term impact.

2.5 Impact Assessment

In order to assess the impact generated during the project, we use the framework described by Horizon Europe recommendations[3]. In these three complementary perspectives: scientific, societal and economic are presented:

Scientific impact: *Promote scientific excellence, support the creation and diffusion of high-quality new fundamental and applied knowledge, skills, training and mobility of researchers, attract talent at all levels, and contribute to full engagement of the Union's talent pool in actions supported under the Programme.*

Societal impact: *Generate knowledge, strengthen the impact of R&I in developing, supporting and implementing Union policies, and support the uptake of innovative solutions in the industry, notably in SMEs, and society to address global challenges, inter alia the Sustainable Development Goals (SDGs).*

Economic impact: *Foster all forms of innovation, facilitate technological development, demonstration and knowledge transfer, and strengthen the deployment of innovative solutions.*

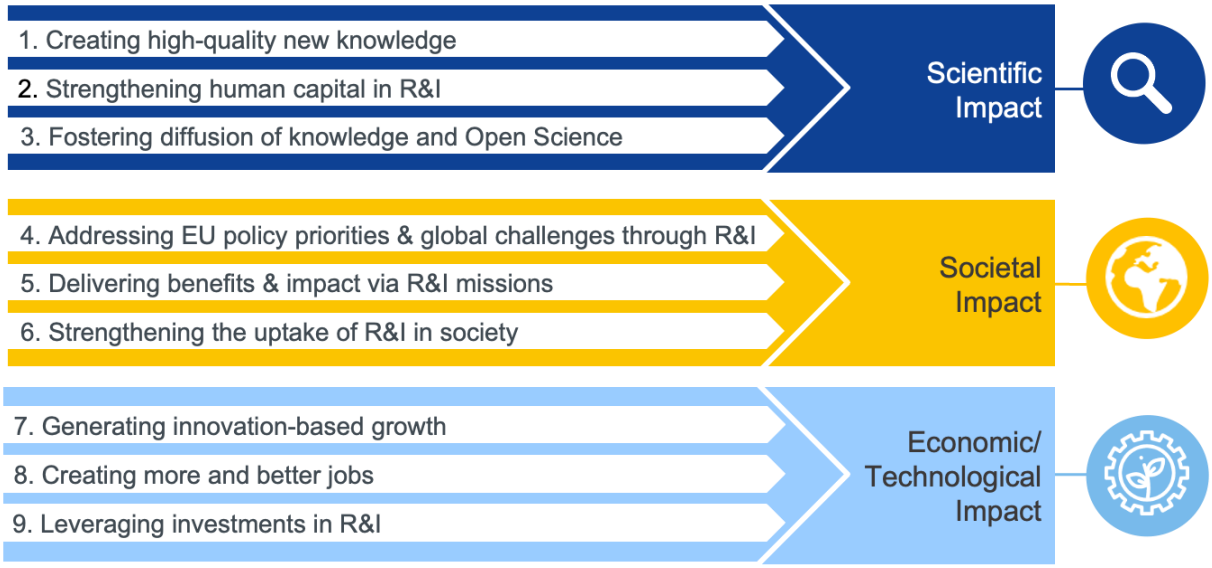


Figure 3: Three impact drivers.[4]

[3] https://ec.europa.eu/research/participants/docs/h2020-funding-guide/other/event210609.htm

[4] https://ec.europa.eu/research/participants/docs/h2020-funding-guide/other/event210609.htm

3 Key Exploitable Results (KERs)

The C-SCALE project has defined 5 Key Exploitable Results (KERs) listed below in detail.

- Federated Earth System Simulation and Data Processing Platform (FedEarthData)
- Metadata Query Service (MQS)
- openEO Platform
- Workflow solutions
- C-SCALE Support

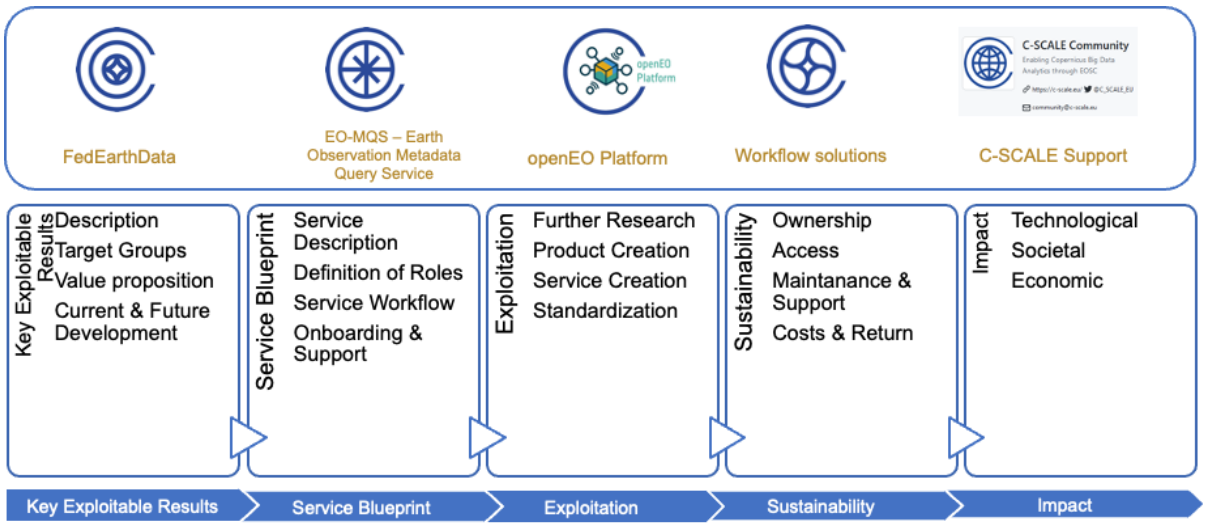


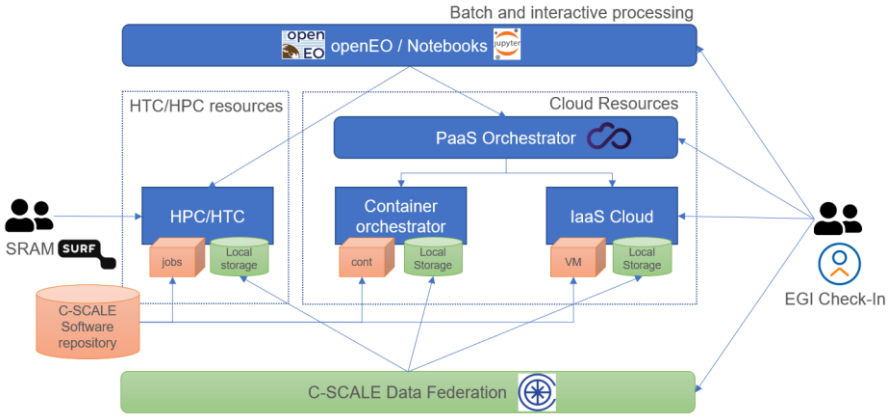
Figure 4: C-SCALE Key Exploitable Results

For each KER we provide: name, owner, short description, picture, target user group, target audiences, target customer/users, value proposition/benefits, developments done during the project, future plans, Technology Readiness Level (TRL), how to access the KER and any further reference.

3.1 KER1 - FedEarthData

Table 1: Description of KER1 - FedEarthData

KER Name	Federated Earth System Simulation and Data Processing Platform (FedEarthData)
KER Owner	EGI Foundation
Short Description	The Federated Earth System Simulation and Data Processing Platform brings together providers of data and processing capacity so that Earth Observation products held in distributed archives across the federation can be easily discovered and seamlessly accessed and processed on batch

	as well as interactive analytic platforms deployed on distributed computing resources anywhere across the federation.
Picture	FedEarthData: federation of Earth observation data archives and computing resource providers, enabling execution of Earth observation processing workflows with seamless access to data 
Target User Group	Researchers and service providers
Target Audiences aligned with Horizon Platform	• Research and Technology Organisations • Academia/ Universities • Private Investors • Public or private funding institutions - secondary • International Organisations (ex. OECD, FAO, UN, etc.) - secondary
Target Customers/Users aligned with Horizon Platform	• Individuals • SMEs • Big corporations • Academia • R&T organisations • Public Institutions and Authorities
Value Proposition / Main Benefits	Value proposition: • Seamless, single sign-on access to Infrastructure-as-a-Service clouds, High-Throughput Compute, High-Performance Compute and storage resources. • Platform services to manage complex workloads, train AI models, deploy automated clusters, run containerised applications and perform interactive analysis with Notebooks. • Federation services to manage user access. Main benefits: • Create and execute Earth Observation data processing workflows.

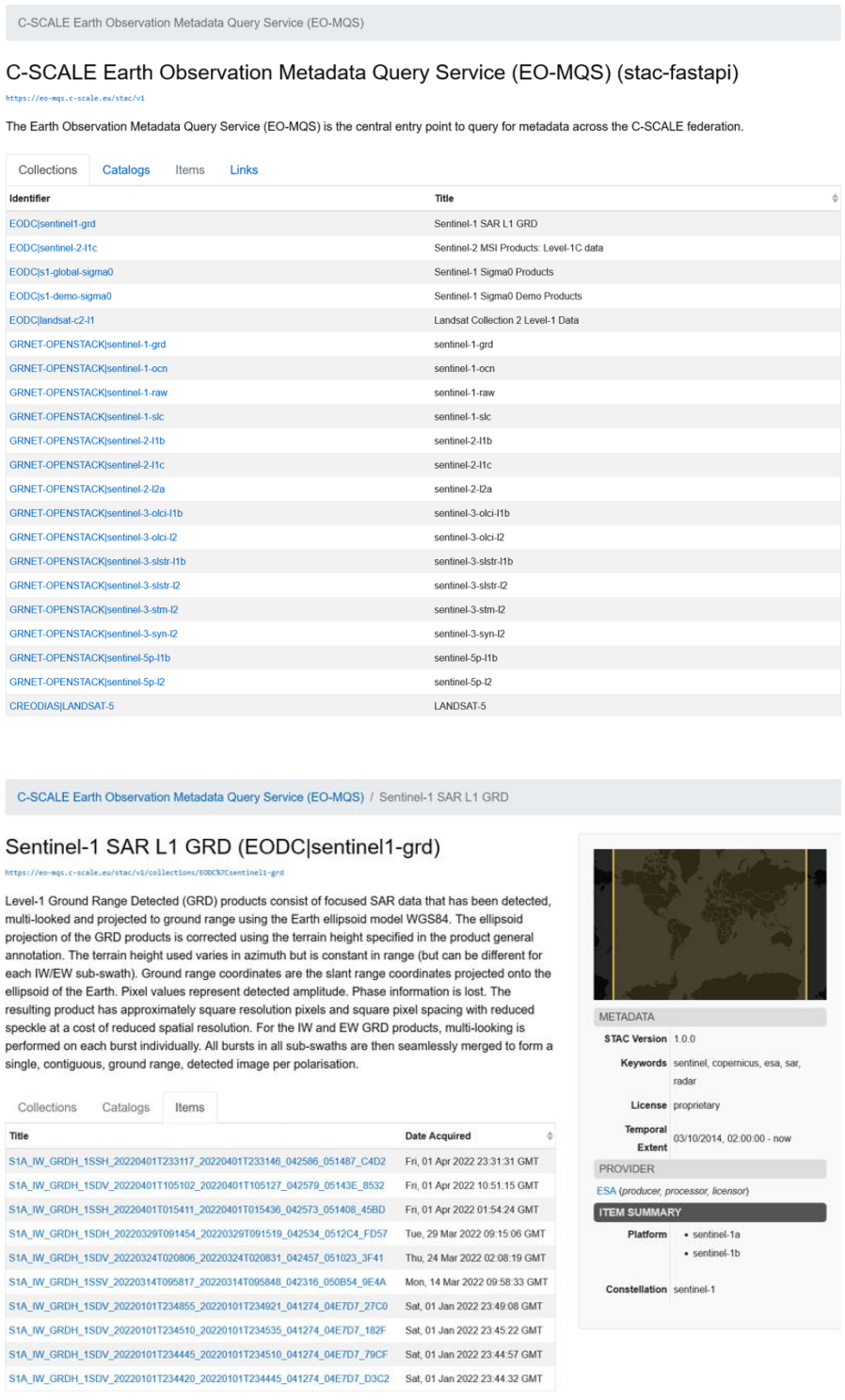
	• Easily access European Cloud IaaS to process EO data and reduce reliance on proprietary, commercial cloud platforms. • Access a large repository of Copernicus data collections. • Receive support for the development of scalable cloud-agnostic and interoperable solutions for EO data processing. • Develop collaboration with European research infrastructures. • Contribute to raising awareness about the European Open Science Cloud and its community. • Flexibility in the choice of platforms and APIs to fetch and process the data when compared to proprietary alternatives where everything is predefined for the users.
Developments done in C-SCALE Project	• Integration activities of computing and data federation of service providers as described in Annex 1 including: • Integration of cloud providers with EGI Check-in • Integration of EGI Check-in with EO Data providers. • Integration of SRAM with HPC/HTC providers. • Successful proof of concept integration using SRAM (as community AAI) and EGI Check-in (as Infrastructure proxy). • Deployment of openEO back-end across C-SCALE cloud providers. • Move integration of SRAM and Check-in from the demo environment to production • Definition of the FedEarthData service, its blueprint and its onboarding into the EOSC Marketplace.
Future Developments / Next Steps	• Interface (wizard) to simplify and automate compute, data and storage provisioning. • Batch data loading system for porting data from internal systems or from commercial cloud. • Expose application results via API instead of Apache HTTP server. • Make data provisioning an (automated) federation action and extend the available datasets in the federation based on user request. • Find a federation-wide solution for accessing data from source and redistributing these in the federation. E.g., CMEMS and CDS require user registration for access.
TRL Level	TRL 8 – system complete and qualified
Access	• C-SCALE Portal: https://c-scale.eu/fedearthdata/ • EOSC Marketplace: https://marketplace.eosc-portal.eu/services/eosc.egi-fed.fedearthdata

Further References	Backeberg, B., Z. Šustr, E. Fernández, G. Donchyts, A. Haag, J. B. R. Oonk, G. Venekamp, B. Schumacher, S. Reimond and C. Chatzikyriakou (2022). An open computer and data federation as an alternative to monolithic infrastructures for big Earth data analytics. Big Earth Data, https://doi.org/10.1080/20964471.2022.2094953 Deliverables: D3.1 Initial Design of the Compute Federation D3.2 Compute federation optimised for Copernicus data analytics D4.1 User feedback report on the functional design of the federation D4.2 Final report on integrating use cases in C-SCALE, including user feedback report

3.2 KER2 - EO-MQS

Table 2: Description of KER2 – EO-MQS

KER Name	Earth Observation Metadata Query Service (EO-MQS)
KER Owner	EODC
Short Description	The Earth Observation Metadata Query Service (EO-MQS) makes Copernicus data distributed across partners within the federation discoverable and searchable. It is a STAC-compliant API that redistributes incoming queries among the federated sites and provides a consolidated response containing the list of aggregated results. The EO-MQS exposes all STAC collections available within the federation on a single endpoint and provides a search interface that accepts the core parameters of the STAC API Item Search specification. Thanks to the rich ecosystem that has evolved around STAC and the growing list of tools that can interact with STAC APIs, working with the EO-MQS is straightforward. The core functionality is MQS API. Additionally, it includes the MQS-Browser library to support visualisation/exploration of the data collections available and a smoke test tool for validation.

Picture	
Target User Group	Researchers and service providers

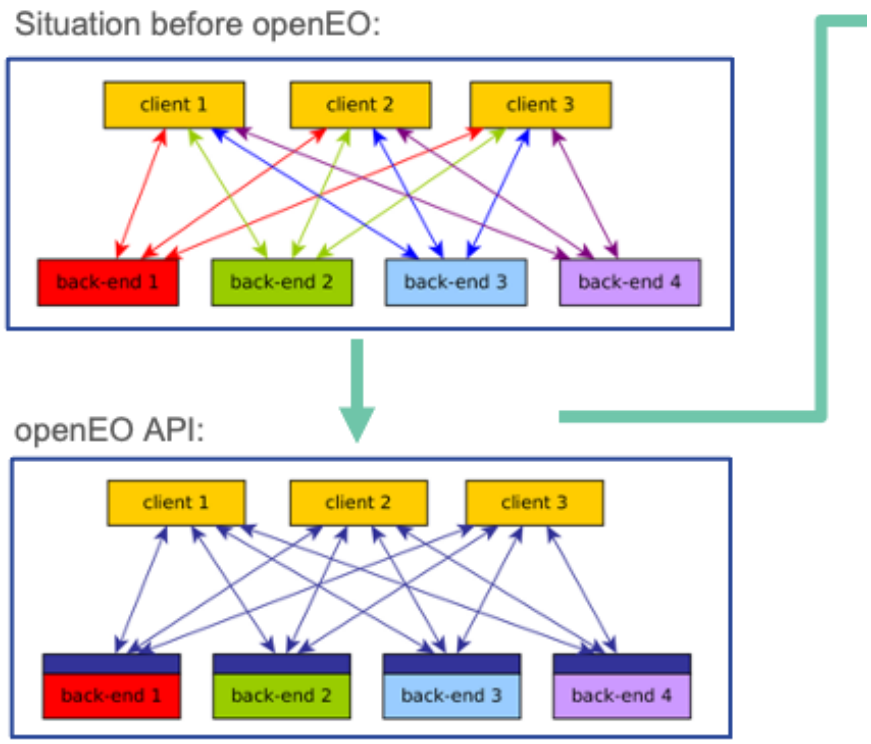
Target Audiences aligned with Horizon Platform	• Public or private funding institutions • International Organisations (ex. OECD, FAO, UN, etc.) • Research and Technology Organisations • Academia/ Universities • Private Investors - secondary
Target Customers/Users aligned with Horizon Platform	• Individuals • SMEs • Big corporations • Academia • R&T organisations • Public Institutions and Authorities
Value Proposition / Main Benefits	Value proposition: • The result provides a standardised interface to search for metadata across the data federation. • It implements STAC, a modern metadata specification for geospatial data and an emerging technology within the geospatial community. • The result fosters the discoverability of Copernicus data and enhances the interoperability between data providers. Main benefits: • Browser-search aggregator for STAC catalogues distributed across a data federation and displays them on the fly with STAC Browser without the need of collecting data on a central database. • Managed service to make it accessible from the website browser without having to perform any extra installation by end users. • Thanks to the rich ecosystem that has evolved around STAC and the growing list of tools that can interact with STAC APIs, working with the EO-MQS is straightforward.
Developments done in C-SCALE Project	• The EO-MQS has been developed from scratch based on STAC-FastAPI which helps build STAC-conformant solutions. • The EO-MQS has been deployed in its initial version on the C-SCALE federated infrastructure. • Service stacks operated by data providers in the C-SCALE federation have been extended to expose STAC interfaces, allowing simple aggregation by EO-MQS. • It currently supports the core parameters of the STAC specification and conforms to STAC version 1.0.0. • Extended API functionalities developed, e.g., improve sorting and filtering of results and exclude unneeded attributes from the response. • Documentation of the EO-MQS and tutorials on how to search and access data have been made available.

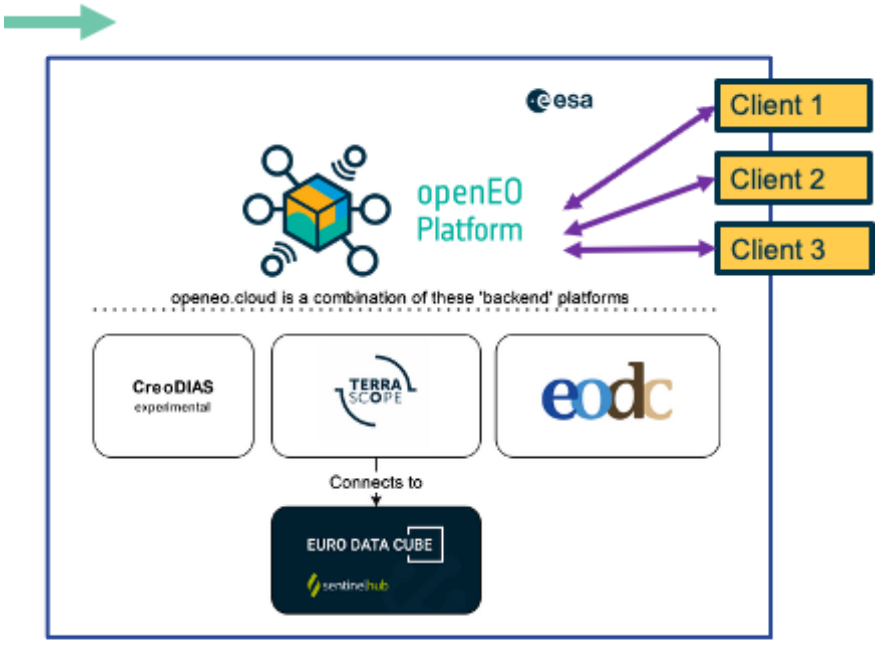
	• Support to develop proper interfaces at data providers within the federation (e.g., GRNET, etc). • Catalogues external to the consortium have been made discoverable (e.g., https://www.reliance-project.eu/).
Future Developments / Next Steps	• Enhance metadata compatibility across the federation by making use of agreed-upon STAC extensions. • Currently working on an Infrastructure as a Code framework for easy redeployment in case of failures. • Upgrade STAC version, e.g., usage filter functionality. • Improve the pre-selection of data providers before the STAC query is re-distributed to make it more efficient. • Expand the number of catalogues. • Add monitoring to the service to measure and improve its availability. • Adapt to the new methodology ESA is going to adopt to publish data.
TRL Level	Between TRL 7 – system prototype demonstration in operational environment and TRL 8 – system complete and qualified.
Access	• C-SCALE Portal: https://c-scale.eu/eo-mqs/ • EOSC Marketplace: https://marketplace.eosc-portal.eu/services/eosc.eodc.eo-mqs
Further References	C-SCALE tutorial: https://youtu.be/cebnrOgoX_I Deliverables: D2.1 C-SCALE Copernicus Data Access and Querying Design D2.2 C-SCALE Copernicus Data Lookup, Access and Dissemination Final Implementation Report

3.3 KER3 - openEO Platform

Table 3: Description of KER3 – openEO Platform

KER Name	openEO Platform
KER Owner	EODC
Short Description	The growing data stream from Earth Observation (EO) satellites has advanced scientific knowledge about the environmental status of planet Earth and has enabled detailed environmental monitoring services.

	However, the growing data lake has become an obstacle for scientists, value-adders and decision-makers. openEO platform provides intuitive programming libraries alongside a large Earth Observation data repository to simplify processing and data management. This large-scale data access and computation is performed on multiple infrastructures using the common openEO API allowing use cases from explorative research to large-scale production of EO-derived maps and information in an accelerated way.
Picture	

	 • Clients: Python, R, Javascript • Web Editor • JupyterLab
Target User Group	Researchers and service providers
Target Audiences	• Public or private funding institutions • International Organisations (ex. OECD, FAO, UN, etc.) • Research and Technology Organisations • Academia/ Universities
Target Customers/Users	• Individuals • SMEs • Big corporations • Academia • R&T organisations • Public Institutions and Authorities • Governments
Value Proposition / Main Benefits	• openEO provides a common language/API that can be used on multiple backend infrastructures (i.e., it is not software or technology specific). • Scaling of processing is not an issue compared to previous (private) infrastructures. • The data management burden is resolved.

Developments done in C-SCALE Project	• Current developments have a strong focus on user co-creation. C-SCALE increased the TRL to Level 8 via WaterWatch and Aquamonitor Use Cases.
	• For the provider's side it has been proven that the openEO backend can be re-deployed within European Federated Infrastructure (FedEarthData).
	• Other improvements introduced during C-SCALE:
	  ○ Extend back-end architecture with more federated openEO back-ends.
	  ○ Client-side processing and immediate displaying of results.
	  ○ Client library improvements.
	  ○ Platform enhancements with use cases - vessel detection and NO2 monitoring.

Future Developments / Next Steps	• Non-interactive authentication. • User workspace.
TRL Level	TRL 8 – system complete and qualified
Access	• C-SCALE Portal: https://c-scale.eu/openeo-platform/ • EOSC Marketplace: https://marketplace.eosc-portal.eu/services/openeo-platform
Further References	Schumacher, B., Griffiths, P., Pebesma, E., Dries, J., Jacob, A., Thiex, D., Mohr, M., and Briese, C.: openEO Platform: Enabling analysis of large-scale Earth Observation data repositories with federated computational infrastructure, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022, EGU22-9101, https://doi.org/10.5194/egusphere-egu22-9101, 2022. Schumacher, B., Griffiths, P., Pebesma, E., Dries, J., Jacob, A., Thiex, D., Mohr, M., and Briese, C.: openEO Platform – showcasing a federated, accessible platform for reproducible large-scale Earth Observation analysis, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-8526, https://doi.org/10.5194/egusphere-egu23-8526, 2023 Deliverables: D3.3 End-user documentation for batch processing system

3.4 KER4 - Workflow Solutions

Table 4: Description of KER4 – Workflow Solutions

KER Name	Workflow Solutions
KER Owner	Workflow individual owners. Currently, Deltares is the owner of the published workflows (https://c-scale.eu/workflow-solutions/)
Short Description	Solutions to easily deploy workflows supporting monitoring, modelling and forecasting of the Earth system.
Picture	 *Aquamonitor using OpenEO on C-SCALE*  *Global Water Watch using OpenEO on C-SCALE*
Target User Group	Researchers and downstream application developers
Target Audiences	• Research and Technology Organisations • Academia/ Universities • Private Investors • International Organisations (ex. OECD, FAO, UN, etc.) (indirect: outputs of the workflows)

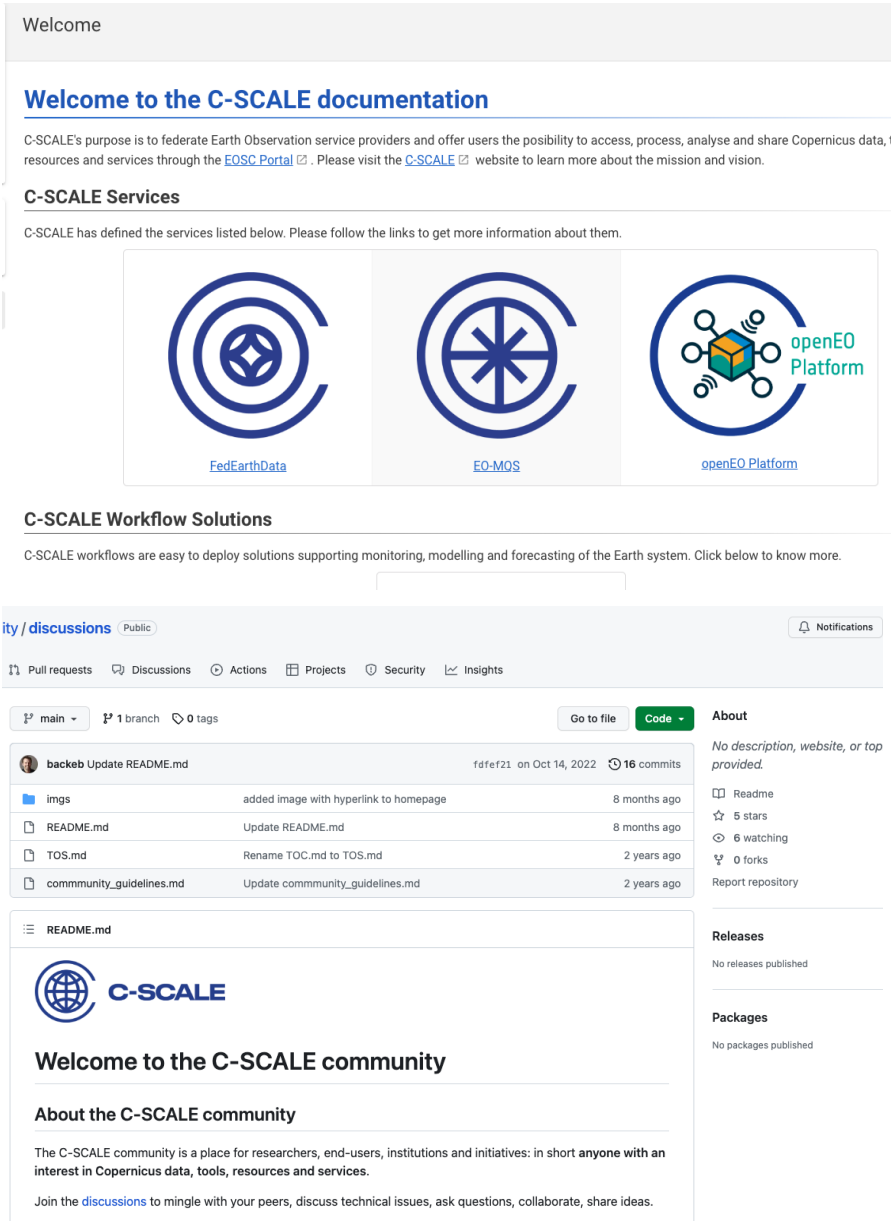
	• EU and Member State Policy-makers (indirect: outputs of the workflows)
Target Customers/Users	• Individuals • SMEs • Big corporations • Academia • R&T organisations • Public Institutions and Authorities • Governments - e.g., national weather services
Value Proposition / Main Benefits	The workflow solutions provide adaptable templates and examples, including Jupyter Notebooks, of Earth Observation and Copernicus data and analysis workflows enabling users to more easily arrange a processing pipeline to create results on the FedEarthData service.
Developments done in C-SCALE Project	Workflows have been refactored and deployed on FedEarthData using existing ones deployed elsewhere. Some of them have also been updated to include openEO as part of the analysis or refactored with Snakemake (a workflow management system). Other developments: • Generalise the use case workflows for easy redeployment to other federation members. • Redeploy the use case workflows to other federation members. • Provide documentation on how to deploy the use case workflows. • Provide example Notebooks that visualise the workflow result. • Register services in EOSC Portal as "Workflow solutions - Easy deployment of workflows supporting monitoring, modelling and forecasting of the Earth system.
Future Developments / Next Steps	• Test the scalability and performance of the workflows by expanding the analyses to larger and/or/ or longer time series. • Build upon the created workflows and reuse their components in follow-up initiatives which involve deploying the workflow for different geographic regions or different computing infrastructures, e.g., ILIFU.
TRL Level	TRL 7 – system prototype demonstration in operational environment
Access	• C-SCALE Portal: https://c-scale.eu/workflow-solutions/ • RoHub: ○ Aquamonitor: https://w3id.org/ro-id/bf39cd09-14d8-4a9c-8d52-d50ef322ab4c

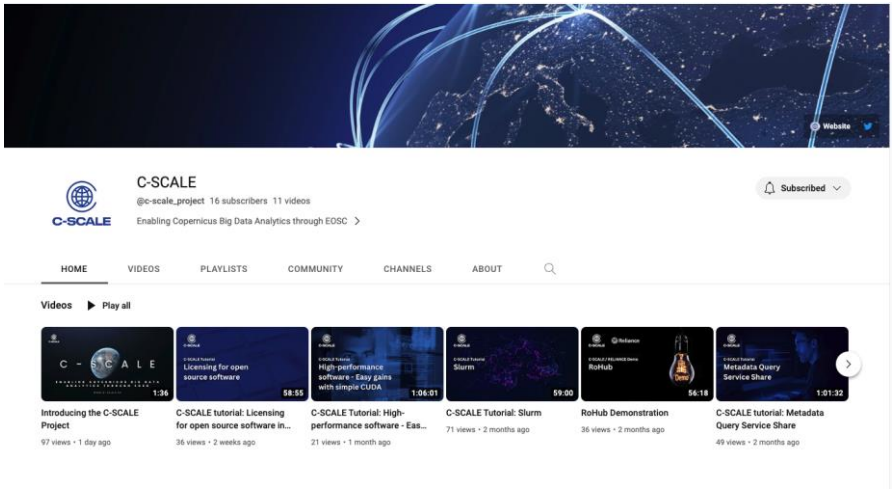
	○ HiSea: https://w3id.org/ro-id/56c970ea-ef0c-4963-845e-1155bad0682a ○ LSDA: https://w3id.org/ro-id/f503fc7e-9e64-40d7-8d35-490a2b358bc3 ○ WaterWatch: https://w3id.org/ro-id/813ac793-f4ba-46d1-9d5e-6552227de7a0 • EOSC Marketplace: https://search.marketplace.eosc-portal.eu/search/other?q=C-Scale%20Workflow%20Solution
Further References	• Quantifying war-induced crop losses in Ukraine in near real-time to strengthen local and global food security: https://doi.org/10.1016/j.foodpol.2023.102418 • Big Data and Machine Learning to Improve European Grapevine Moth (Lobesia botrana) Predictions: https://doi.org/10.3390/plants12030633 • Sperna Weiland, F., Buitink, J., Langemeijer, J., Oonk, R., and Backeberg, B.: Towards automated seasonal river discharge ensemble forecasts on a federated compute and data infrastructure, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-15287, https://doi.org/10.5194/egusphere-egu23-15287, 2023. News items for: • WaterWatch: https://c-scale.eu/interoperable-services-enabling-timely-response-to-climate-related-risks/ • Aquamonitor: https://c-scale.eu/unlocking-global-satellite-data-with-openeo/ • HiSea: https://c-scale.eu/supporting-ports-and-aquaculture-industries/ • LSDA: https://c-scale.eu/towards-automated-ensemble-discharge-forecasts-for-any-river-in-the-world-on-a-federated-compute-and-data-infrastructure/

3.5 KER5 - C-SCALE Support

Table 5: Description of KER5 – C-SCALE Support

KER Name	C-SCALE Support
KER Owner	EGI Foundation
Short Description	Set of activities and resources to engage with existing and new stakeholders, including both researchers and service providers in Earth Observation. It includes the platforms prepared to support the use cases (GitHub, wiki, YouTube, website) and the material generated

	(documentation, publications, videos, tutorials, news articles), and the community of experts (both users and providers) interacting in the forum.
Picture	

	
Target User Group	Researchers and service providers
Target Audiences	• Research and Technology Organisations • Academia/ Universities • Private Investors • International Organisations (ex. OECD, FAO, UN, etc.) - secondary
Target Customers/Users	• Individuals • SMEs • Big corporations • Academia • R&T organisations • Public Institutions and Authorities • Governments - e.g., national weather services
Value Proposition / Main Benefits	Establish a two-way communication where service providers, users, experts and interested parties can exchange knowledge and best practices about optimising data analytics in Earth Observation.
Developments done in C-SCALE Project	All up-to-date content is available through: • GitHub • Wiki • YouTube • Website All material generated: • Documents • Publications • Tutorials

	• Web news • Training Activities
Future Developments / Next Steps	• Update of the documentation and material depending on the owner of each of the services. • Platforms will continue to be available for the new users of C-SCALE-related services.
TRL Level	N/A
Access	• C-SCALE Documentation: https://wiki.c-scale.eu/C-SCALE • C-SCALE Community Support via dedicated GitHub Organisation: https://github.com/c-scale-community/discussions • C-SCALE website: https://c-scale.eu/ • YouTube channel: https://www.youtube.com/@c-scale_project/videos

4 Service Definition and Blueprint

Out of the 5 Key Exploitable Results (presented in Section 2 above), the C-SCALE project has created 3 new services: FedEarthData, EO-MQS and openEO Platform. In this Section we provide further details for the three services, covering the description and the service blueprint.

4.1 4.1. FedEarthData

4.1.1 Service description

The Federated Earth System Simulation and Data Processing Platform Service (FedEarthData) provides a distributed infrastructure of data and compute providers to support the execution of Earth System Simulation and Data Processing workflows at scale to EOSC researchers.

It offers a flexible cloud-based data processing capacity to create and scale data processing pipelines that run on optimised execution environments near the data. Jupyter Notebooks and openEO API offer user-friendly and intuitive processing of a wide variety of Earth Observation datasets on these computing providers, including the ability to integrate these data with modelling and forecasting workflows leveraging specialised compute resources.

Providers of the Copernicus Data Processing Platform already count with an extensive collection of Copernicus datasets, managed according to the FAIR principles, and may be further extended with new datasets requested by users of the platform.

4.1.2 Definition of roles

- Users/Customers: international students and researchers, research organisations, projects, communities and groups, as well as businesses and innovators who are interested in executing their Copernicus and/or Earth Observation data processing and analysis workflows.
- C-SCALE Evaluation and Brokering Team: Core team including computing service technical representative, EO application domain expert and administrative executive.
- C-SCALE Service Provision Team: Representatives of the Service Providers including federated computing infrastructures, data and platforms such as openEO and JupyterHub.

4.1.3 Service blueprint

How to get access (see Figure 5 below):

- Users/Customers find the service via either the EOSC marketplace and C-SCALE website, and it is expected to be extended to the EGI website, EODC website and to Horizon Results Platform among others.
- Users/Customers are required to fill out a form to collect the following information:
  a. Contact information
  b. Project information: brief description, scientific and computing objectives.
  c. Who are the beneficiaries

d. What are the requirements: software/platform, hardware, and data requirements.

- Once filled out, the form should be emailed to C-SCALE (contact@c-scale.eu) for review.
- The C-SCALE Evaluation and Brokering Team receives the order request via email and replies to the customer confirming reception of the request and giving an estimated deadline for its evaluation.
- Order requests are collected on a monthly cut-off basis, after which all the applications received during the period are evaluated by the C-SCALE Evaluation and Brokering Team performing the following screening for each order request:
  a. Administrative check: is it relevant to Earth Observation or to the study of Earth processes?
  b. Technical check: taking into account the current federated infrastructure, can C-SCALE serve the requested computational requirements?
- Order requests meeting both the administrative and technical requirements are then circulated among the C-SCALE Service Provision Team in order to assess hosting infrastructure candidates.
- C-SCALE Service Providers have one week to evaluate the order request and propose themselves as candidates to serve the customer.
  a. In the case that none of the Service Providers are interested, the C-SCALE Evaluation and Brokering Team will notify the User/Customer to adjust the order request or discard it.
- When one or more Service Providers are willing to serve the order request, the C-SCALE Evaluation and Brokering Team will assist User/Customers with the most suitable provider for the user/customer according to the following assumptions:
  a. country of the User/Customers is the same as the provider,
  b. alignment between User/Customers and Service Provider regarding technical or scientific goals, or
  c. better value for money when the customer is willing to pay for the services. All service delivery offers are provided to the customer to select the most adequate one.
- Once the Service Provider(s) are selected for the order request, the C-SCALE Evaluation and Brokering Team arranges a kick-off meeting with the relevant stakeholders (User/Customer and Service Provider) in order to:
  a. introduce each other
  b. complete and agree on the Service Level Agreement (SLA).
- FedEarthData resources are then provisioned to the User/Customers under the conditions agreed in the SLA.
- C-SCALE Evaluation and Brokering Team will arrange a regular meeting every 6 months to monitor order progress and customer satisfaction with the provision of resources, with the aim to ensure the quality of the services delivered under FedEarthData.

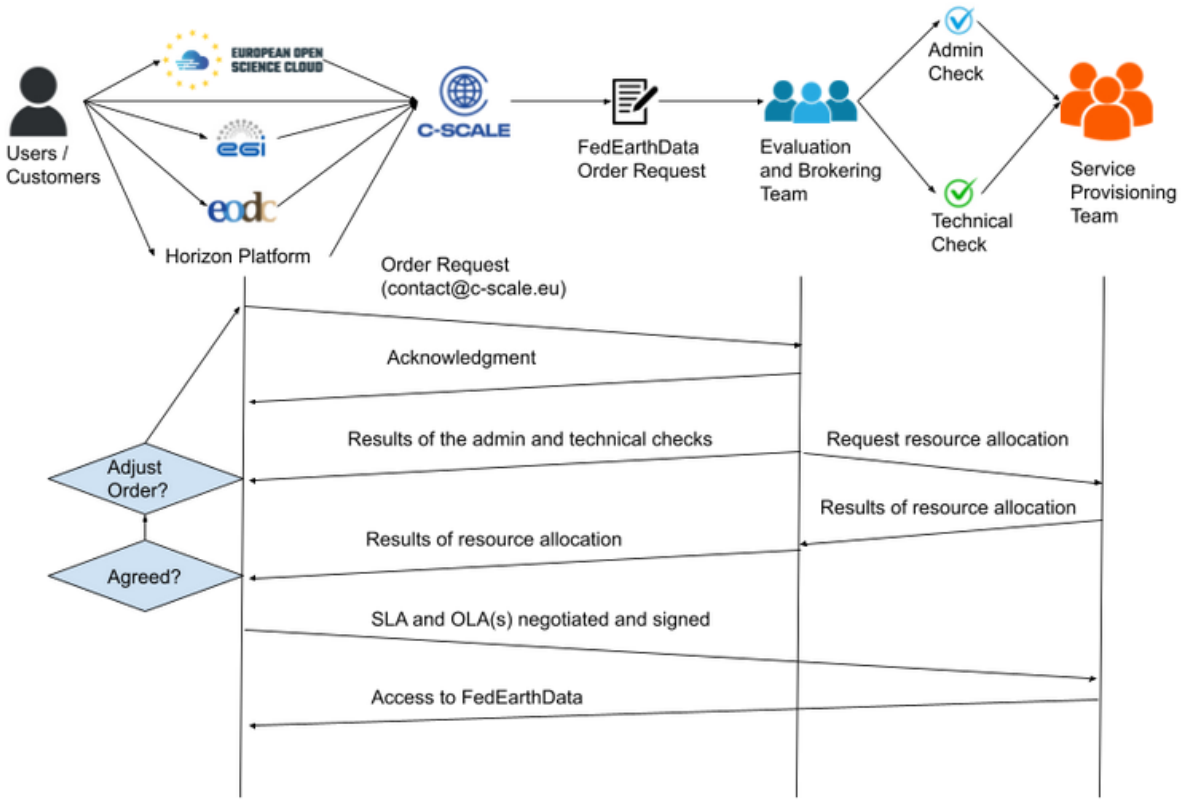


Figure 5: Service Blueprint for FedEarthData

How to get help:

- Users/Customers are first redirected to the documentation and training material: https://wiki.c-scale.eu/C-SCALE/c-scale-services/fedearthdata.
- Support for FedEarthData can also be requested via the EOSC Helpdesk, either via email (c-scale@eosc-portal.eu) or https://helpdesk.c-scale.eu/. C-SCALE 1st line support receives the help request, tries to answer the customer or redirects the request to the appointed support responsible within the service provider.

4.1.4 How to be onboarded

New providers are welcome to join the FedEarthData Service following one or more of the following options (see Figure 6 below): 1) as infrastructure providers (Cloud, HTC/HPC), 2) service providers (JupyterHub, openEO), and 3) data providers.

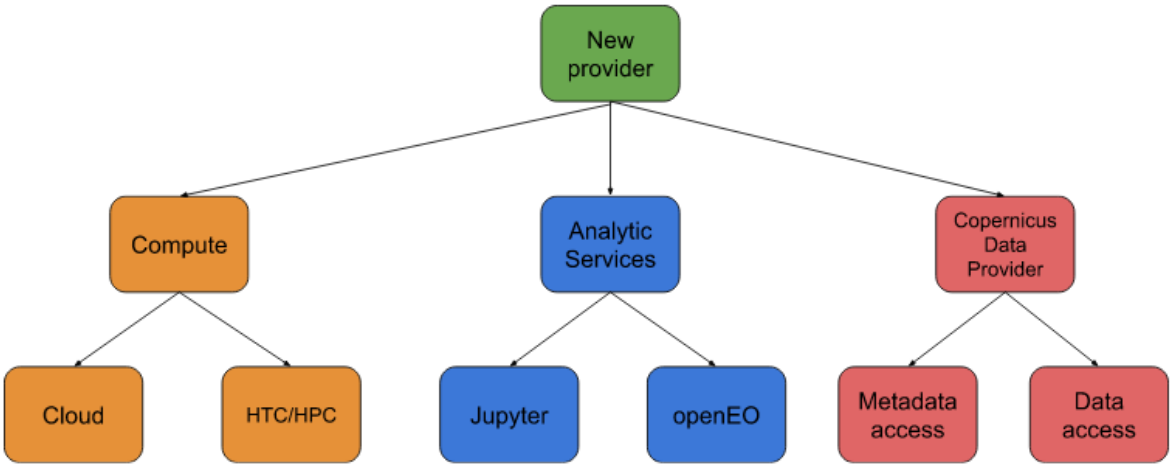


Figure 6: Options that a new provider can become part of the FedEarthData service

Infrastructure providers. Infrastructure providers are those operating computing resources in the form of cloud and/or HTC/HPC clusters.

- Cloud providers wanting to join FedEarthData are expected to run OpenStack as the Cloud Management Framework of choice. Cloud providers need to configure OpenStack to connect to EGI Check-in, the AAI underpinning the cloud federation. The steps for cloud providers to be onboarded in C-SCALE are documented in D3.1, Section 3.4.
- A common denominator for HTC/HPC providers in FedEarthData is to operate a local LDAP directory for user management that will be automatically synchronised with SURF Research Access Management (SRAM), the AAI underpinning the HTC/HPC federation. The steps for HTC/HPC providers to be onboarded are documented in D3.1, Section 4.3.

Service providers. Service providers are expected to contribute either with a JupyterHub instance and/or with an openEO back-end deployment.

- Providers running an instance of JupyterHub optimised for Copernicus data analytics are welcome to join FedEarthData. A mandatory step is to federate JupyterHub with EGI Check-in, following these instructions: https://docs.egi.eu/providers/check-in/sp/.
- Some providers in the C-SCALE project have deployed their own back-end of openEO to better serve certain use cases. In particular, INCD has shared instructions on how to deploy openEO via their GitLab repository. Additionally, INFN has built a TOSCA template to automate the deployment of openEO backend using the PaaS Orchestrator. Detailed instructions are provided in D3.2, Section 2.3 for those new providers that would like to deploy their own openEO back-end and join FedEarthData.

Data providers. Copernicus data providers operating a STAC API endpoint may be onboarded in two complementary ways: 1) metadata access and/or 2) data access. Metadata access refers to the ability to show information about what data is hosted at the provider. Data access refers to the ability to download the data from external parties. Here we summarise how a Copernicus data

provider can join FedEarthData via option 2) data access. EO-MQS below discusses how to be onboarded via option 1) metadata access.

- Open Access: this is the simplest scenario. Users can freely download the data from the provider and there are no further actions required.
- Authorised Access: this is a common requirement for certain providers that need to account for how many times each data product has been downloaded by whom. Section 4 in D2.2 explains the steps to configure EGI Check-in to authorise access to data products in C-SCALE and also via: https://wiki.c-scale.eu/C-SCALE/c-scale-services/fedearthdata/data-federation.

Initially, FedEarthData started using EGI Check-in as the AAI system to control user access to cloud resources, analytic services and data access, and SRAM as the AAI system to control user access to HTC/HPC resources. After extensive discussions and collaboration efforts, in May 2023 C-SCALE tested a proof of concept connection between the two AAI systems where SRAM plays the role of a Community AAI and EGI Check-in plays the role of an Infrastructure Proxy. The test demonstrated that a user with an account in SRAM could successfully log into a cloud provider configured with EGI Check-in. This is the first step towards the harmonisation of AAI systems in the FedEarthData service.

Providers looking for support on how to join the C-SCALE federation should contact us via https://helpdesk.c-scale.eu or email at c-scale@eosc-portal.eu.

Once a new provider/service has been federated, we will update both the C-SCALE website and the EOSC Marketplace entry accordingly to reflect the change.

4.1.5 EOSC marketplace

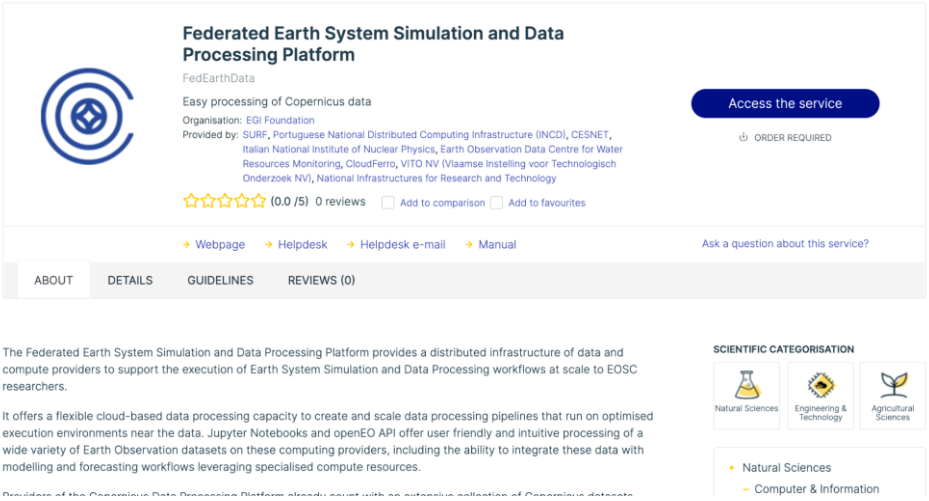


Figure 7: FedEarthData entry in the EOSC Marketplace: https://marketplace.eosc-portal.eu/services/federated-earth-system-simulation-and-data-processing-platform

4.2 EO-MQS

4.2.1 Service description

The C-SCALE Earth Observation Metadata Query Service (EO-MQS) makes Copernicus data distributed across providers within the C-SCALE Data federation discoverable and searchable. The EO-MQS is a STAC-compliant service that exposes all collections available within the federation on a single endpoint. Through a search interface, users' queries are redistributed among the data providers and a consolidated list of results is returned.

Thanks to the rich ecosystem that has evolved around STAC and the growing list of tools that can interact with STAC APIs, working with the EO-MQS is straightforward. Data providers maintaining their data assets in STAC catalogues can easily integrate them into the EO-MQS to increase their discoverability.

4.2.2 Definition of roles

Users/Customers: international students and researchers, research organisations, projects, communities and groups, as well as businesses and innovators who are interested in discovering Copernicus and/or Earth Observation data.

4.2.3 Service blueprint

How to get access (see Figure 8 below):

- Users/Customers find the service via either the EOSC marketplace and the C-SCALE website, and it is expected to be extended to the EODC website and the Horizon Results Platform among others.
- From the C-SCALE website the Users/Customers can then access the service (https://eo-mqs.c-scale.eu/) or the EO-MQS help page (https://eo-mqs.c-scale.eu/help/).
- Users/Customers do not need to register or request access since the EO-MQS is fully open via a web browser or a programmable interface (API).
- Ready-to-use API examples of STAC packages are available from the EO-MQS help page and C-SCALE GitHub: https://github.com/c-scale-community/c-scale-tutorial-eo-mqs.

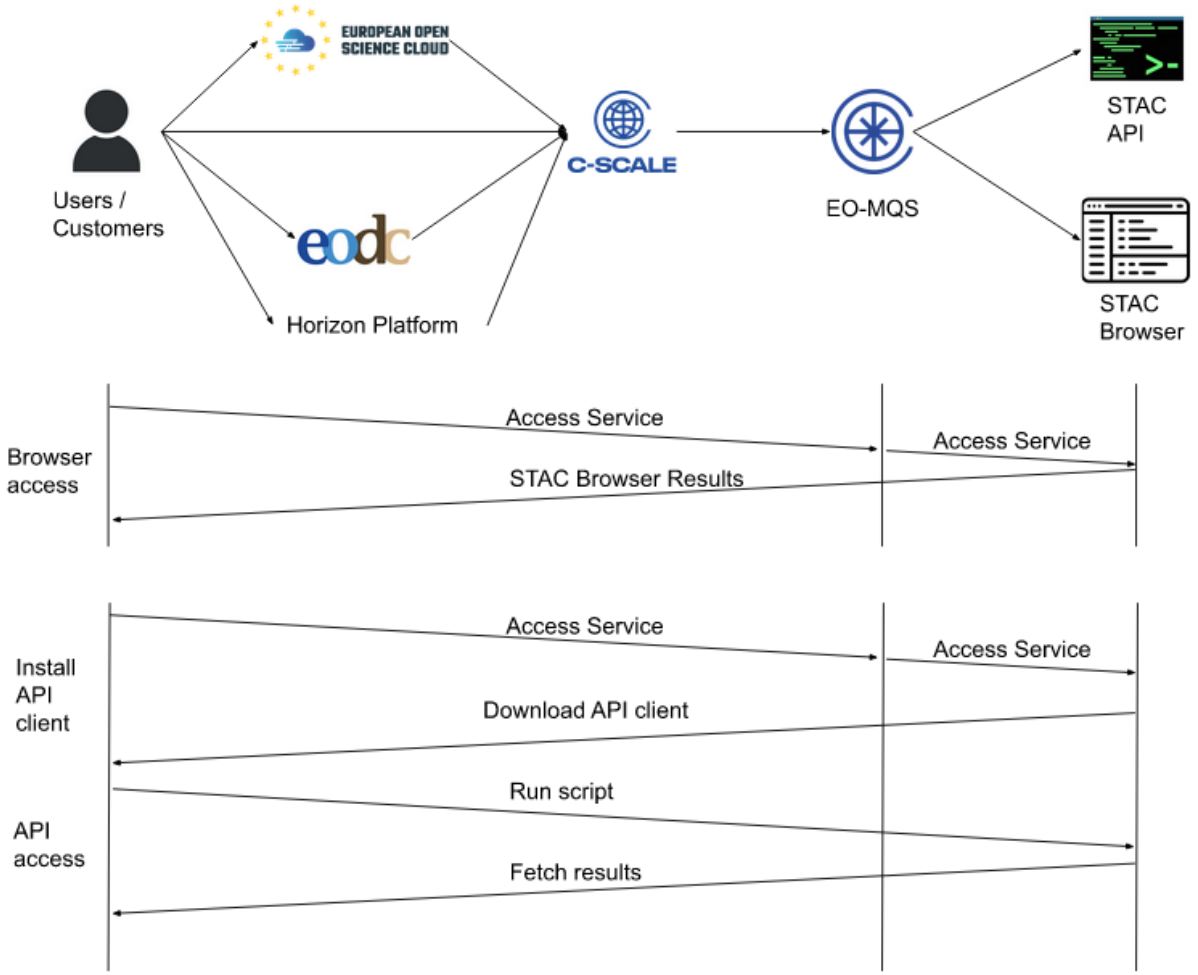


Figure 8: Service Blueprint for EO-MQS

How to get help:

- Users/Customers can get initial guidance from the C-SCALE documentation.
- There is a dedicated EO-MQS help page to get further information.
- Support for EO-MQS can also be requested via the EOSC Helpdesk, either via email (c-scale@eosc-portal.eu) or https://helpdesk.c-scale.eu/. C-SCALE 1st line support receives the help request, tries to answer the customer or redirects the request to a specialised unit (service provider).

4.2.4 How to be onboarded

Copernicus data providers operating a STAC API endpoint may be onboarded in two complementary ways: 1) metadata access and/or 2) data access. Metadata access refers to the ability to show information about what data is hosted at the provider. Data access refers to the ability to download the data from external parties. The FedEarthData service above discussed how a Copernicus data provider can join the C-SCALE federation via option 2) data access. Those providers who want to join

the EO-MQS service instead via 1) metadata access, need to follow the steps in Section 3 in D2.2 or via: https://wiki.c-scale.eu/C-SCALE/c-scale-services/fedearthdata/data-federation.

4.2.5 EOSC marketplace

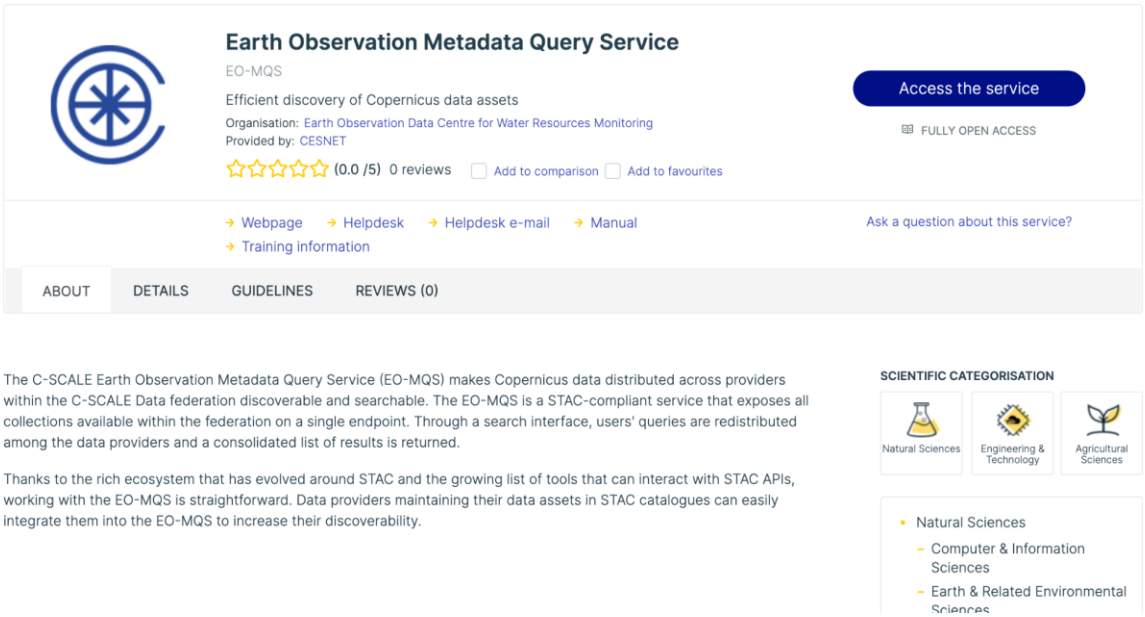


Figure 9: EO-MQS entry in the EOSC Marketplace: https://marketplace.eosc-portal.eu/services/earth-observation-metadata-query-service

4.3 openEO Platform

4.3.1 Service description

openEO platform provides intuitive programming libraries to process a wide variety of Earth Observation datasets. This large-scale data access and processing is performed on multiple infrastructures, which all support the openEO API. This allows use cases from explorative research to large-scale production of EO-derived maps and information. Currently, a wide variety of researchers, developers and EO data specialists are using the Platform for their needs.

4.3.2 Service blueprint

How to get access (see Figure 10 below)

- Users/Customers find the service via either the EOSC marketplace and the C-SCALE website, and it is expected to be extended to the EODC website and the Horizon Results Platform among others.
- Users/Customers are required to get an EGI Check-in account and register at EOPlaza. After signing up, they have two options:
  a. Piloting activities: 30-day free trial to access and test the service.

b. Well-defined projects: access via the ESA Network of Resources to execute production-ready workloads.

- Once registration is complete, openEO Platform offers a wide variety of interfaces:
  a. Command-line interface via:
     - JavaScript, Python and R
  b. Browser-based interface via:
     - openEO Platform Editor and Jupyterlab

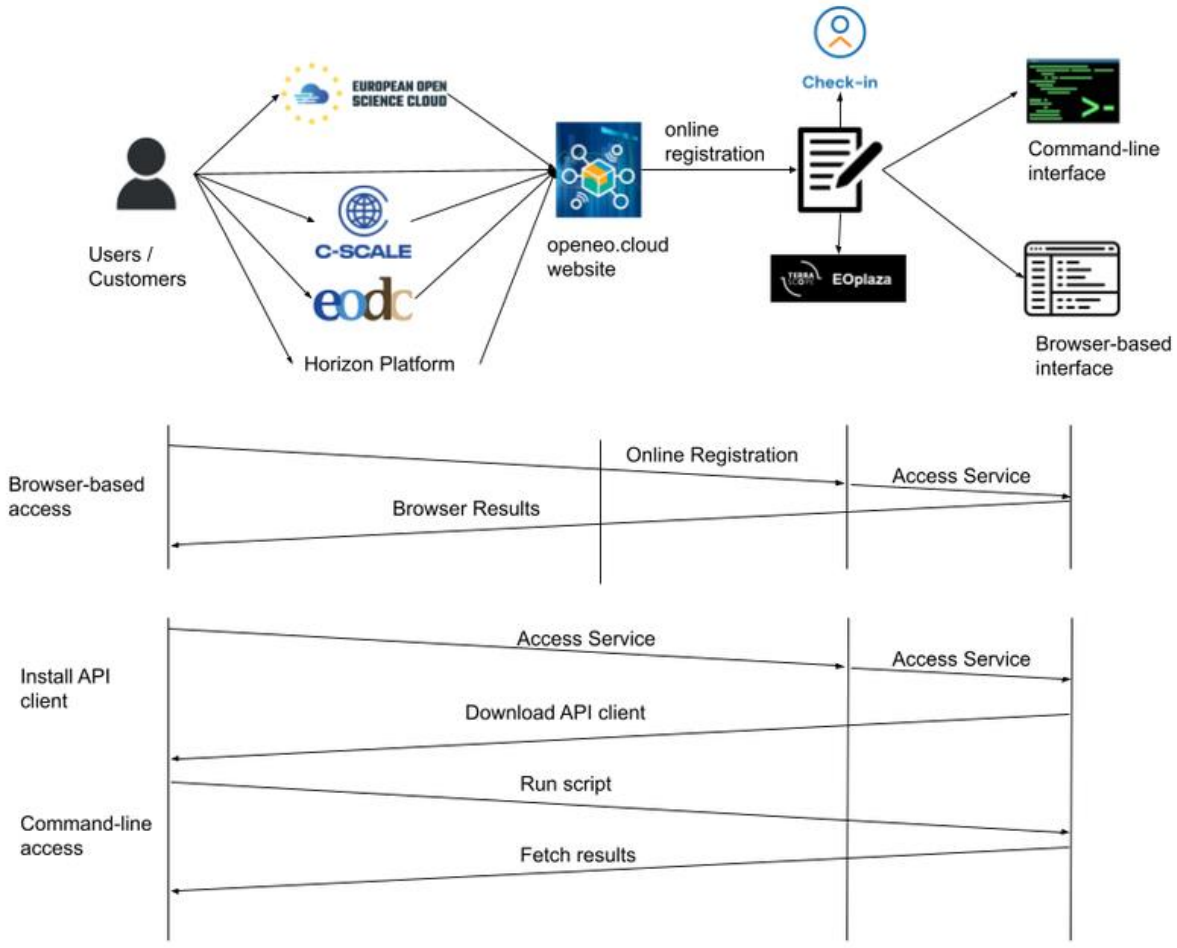


Figure 10: Service Blueprint for openEO Platform

How to get help:

- Users/Customers can get initial guidance from the C-SCALE documentation.
- There is a dedicated openEO Platform documentation page and a C-SCALE tutorial to get further information
- Support for OpenEO Platform can also be requested via email (openeo-platform@eodc.eu), user forum (https://discuss.eodc.eu/c/openeo-platform/5) and

the EOSC Helpdesk, either via email (c-scale@eosc-portal.eu) or https://helpdesk.c-scale.eu/.

4.3.3 EOSC marketplace

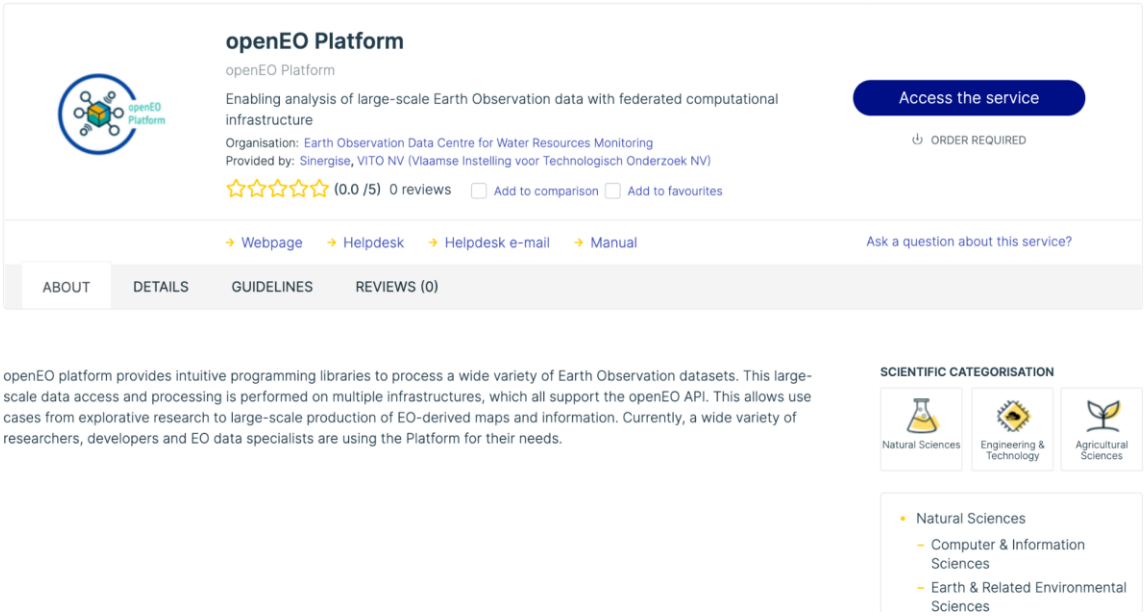


Figure 11: openEO Platform entry in the EOSC Marketplace: https://marketplace.eosc-portal.eu/services/openeo-platform

5 Exploitation and Sustainability

In this section, we describe the exploitation plans and activities for each of the Key Exploitable Results (KERs) presented in Section 2 above.

5.1 Exploitation Activities and Achievements

Table 6: Exploitation Activities and Achievements per KER

KER1: FedEarthData	• **Further Research:** Know-how generated and further improvements on FedEarthData service and some of their building blocks expected to be followed up as part of follow-up projects. • **Creation or improvements of Products and Services**: C-SCALE Compute and Data federation has enabled the full definition of FedEarthData service (this KER) - which has been made available through the EOSC Marketplace. • **Standardisation:** Interoperability with EOSC - e.g., using common Authorisation and Authentication Infrastructure (AAI) to access the FedEarthData, usage of de-facto standard cloud management framework (OpenStack) and distributed resource management systems (Slurm) - which enables easy integration of new resource providers.
KER2: EO-MQS	• **Service Creation:** The EO-MQS is openly available on a public URL and can be discovered on the C-SCALE website and EOSC Marketplace. • **Product Creation:** STAC developments (EO-MQS, MQS-Postman, MQS-Browser will be open-sourced under MIT License) and available from C-SCALE GitHub, posted to Zenodo / RoHub - and therefore also visible from EOSC Marketplace. • **Further Research:** Internal re-use for indexing EODC catalogues and to be further developed in follow-up EU projects. • **Standardisation activities**: Adoption and alignment with STAC standard.
KER3: OpenEO Platform	• **Service Creation:** openEO Platform is freely available for 1 month to anyone. Researchers can request access through the ESA Network of Resources for Pre-commercial Research and Educational Purposes. openEO platform is also available for Commercial services under an available commercial licence via Terrascope Marketplace[5]. • **Further Research:** Know-how generated and building blocks to be re-used and further developed in follow-up EU projects.
KER4: Workflow Solutions	• **Product Creation:** Users can discover the workflow solutions through the EOSC Marketplace or the C-SCALE website. Following the

[5] https://terrascope.be/en/news-events/brand-new-marketplace-access-and-offer-eo-services

	documentation, the user can deploy and customise the workflow to suit the users' needs using the FedEarthData service. • **Further Research:** Building blocks / Components of the workflow solutions will be re-used and further developed, when necessary, within follow-up projects (such as the interTwin project[6]) or the Destination Earth initiative. • **Service Creation:** In longer-term workflow solutions, building blocks and the generated know-how can support the development of Monitoring and Forecasting as a service solution.
KER 5: C-SCALE Support	• **Product Creation:** All project-generated material will be kept available on the different platforms and ready to use and download. Most of the material is shared under open licences (e.g., CC BY for Documentation, or open-source licences for workflows and software). • **Further Research:** The different activities for the community development undertaken under C-SCALE can be re-used for further projects and endeavours (e.g., interTwin open source Community is adopting some of the best practices that were developed within C-SCALE).

5.2 Sustainability Plans and Achievements

Main achievements and work towards ensuring the sustainability of each of the KERs after the end of the project are summarised in the following table:

Table 7: Sustainability Plans and Achievements per KER

KER1 - FedEarthData	The technical integration of all the FedEarthData infrastructure includes Sentinel archives, private clouds, private HPC/HTC resources and other services that are owned by different providers. As such, the sustainability of the service is linked with the sustainability of its components and the guarantee of its providers to keep on delivering the corresponding services. Thereby sustainability has been ensured by three different aspects: • Getting the commitment of the resource providers to continue the delivery of the service, • Incorporating FedEarthData itself as a project-related service within the EGI portfolio, • By enhancing already existing tools and services provided by project partners.

[6] https://www.intertwin.eu/

	Every resource provider has signed a Letter of Commitment to continue the delivery of the service provisioning after the end of the project under certain conditions. The baseline of the Letter of commitment is provided in Annex 2. This was adapted to each of the different resource providers according to their preferences. FedEarthData has been incorporated as a project-related service within the EGI Portfolio of services. It includes: • Data access is open and free to all registered users without limitation. • Limited compute resources, especially for interactive processing, are available to registered users. • Substantial processing resources are available upon order. Some components/building blocks have improved already existing EGI services - enriching the EGI ecosystem - and will remain available after the end of the project: • New cloud providers have been incorporated into the EGI Cloud Compute Service. • Check-in capabilities extended to enable SRAM users to access services behind EGI Check-in (and hence facilitate the interoperability between the different AAI solutions - and facilitate the access to EGI services for SRAM-based user community - which includes HPC/HTC users. • Streamlining access to Copernicus Data via EGI Notebooks that will facilitate the usage of the service in EO domains and hence enable an increased user base for the service. • Similarly, the PaaS orchestrator work by INFN also improved the existing INFN cloud offer that has the PaaS as the basis[7].
KER2 - EO-MQS	• The result contributes to the integration of metadata databases which is a central component of the Copernicus Data Federation activity within C-SCALE. The EO-MQS has generated expertise that is going to be used beyond the project for realising federated metadata integration. • The STAC endpoints deployed at the individual sites present a clear added value for the discoverability of their hosted data and are likely to stay beyond the project. • EODC / CESNET will keep maintaining the EO-MQS tools and service after the end of the project. • Basic support is given from EODC / CESNET and documentation and tutorials are available from the website. • EODC will keep working towards expanding the catalogue (onboarding new data providers). • Strong interest from the community to keep the catalogue growing.

[7] https://www.cloud.infn.it/service-catalogue/

KER3: OpenEO Platform	openEO Platform contributes to scientific equity, to the federated European-wide computation infrastructure for Earth Observation data and provides openEO API, an open source alternative to commercial Earth Observation analysis tools. The service provides freely available training and documentation for any level of expertise. openEO Platform is providing a sustainable service for the public, private and research sectors which eases access to EO data and compute resources. After C-SCALE, an openEO Management board will be constituted to maintain the service operational. Operations will be covered under follow-up funding projects (ESA, interTwin) or paid under commercial.
KER4: Workflow Solutions	• The workflow solution provider offers open source software with documentation (incl. training material) on how to deploy the workflow towards creating a result for a user's region of interest. • The workflow solution provider offers no warranty or dedicated support for the service but can offer guidance and training on how to deploy the workflow. • The workflow solution for coastal hydrodynamic and water quality modelling using Delft3D FM is planned to be reused with South African partners developing highly accurate model-based data for ports and estuaries supporting the South Africa's Ocean and Coastal Information Management System. • Outcome of this, EGI user base could be expanded capitalising on the fact that South African provider ILIFU was already part of the EGI Cloud Federation, as such they have been able to support follow-up demonstration or the HiSea Use Case.
KER 5: C-SCALE Support	• Most of the communication channels presented in the exploitation plan are free to use. • Communication platforms will be kept available for long-term information exchange between the community members. Community management will be done on a best-effort basis or as part of follow-up EO-related project initiatives. • Each of the services (FedEarthData, EO-MQS, openEO Platform) has defined a specific level of support available to end users. A discussion forum is kept available for all of them for any necessary technical discussion. Also is available for the Workflow solutions, both as a repository for the generated solutions and a discussion forum for existing or any future new solutions. Update of the documentation and material will be done depending on requests of new users'/customers' needs. • The different activities for the community development undertaken under C-SCALE can be re-used for further projects and endeavours (e.g.,

	interTwin open source Community is adopting some of the best practices that were developed within C-SCALE).

6 Impact Assessment

6.1 Impact on science

6.1.1 Creating high-quality new knowledge

The C-SCALE project has made significant contributions to creating high-quality new knowledge. It has advanced Earth Observation (EO) technologies and developed innovative solutions in areas such as data federation, metadata integration, workflow solutions, and open-source platforms. Through the project's Key Exploitable Results (KERs), such as the FedEarthData service, EO-MQS, openEO Platform, and Workflow Solutions, C-SCALE has fostered scientific advancements in EO data management, interoperability, and analysis. The project has also contributed to standardization efforts by aligning with established frameworks and promoting the adoption of common standards.

Means of Verification:

3 publications in relevant peer-reviewed journals and more than 55 dissemination activities, including presentations in major relevant conferences in the sector (e.g. EGU, Living Planet Symposium, EOSC Symposium, EGI Conference, EODC Forum).

Examples of publications:

- Backeberg, B., Z. Šustr, E. Fernández, G. Donchyts, A. Haag, J. B. R. Oonk, G. Venekamp, B. Schumacher, S. Reimond and C. Chatzikyriakou (2022). An open computer and data federation as an alternative to monolithic infrastructures for big Earth data analytics. Big Earth Data, https://doi.org/10.1080/20964471.2022.2094953
- Quantifying war-induced crop losses in Ukraine in near real-time to strengthen local and global food security: https://doi.org/10.1016/j.foodpol.2023.102418
- Big Data and Machine Learning to Improve European Grapevine Moth (Lobesia botrana) Predictions: https://doi.org/10.3390/plants12030633

Examples of conference participation:

- Sperna Weiland, F., Buitink, J., Langemeijer, J., Oonk, R., and Backeberg, B.: Towards automated seasonal river discharge ensemble forecasts on a federated compute and data infrastructure, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-15287, https://doi.org/10.5194/egusphere-egu23-15287, 2023;
- Fouilloux, A., Marasco, P. L., Odaka, T., Mottram, R., Zieger, P., Schulz, M., Coca-Castro, A., Iaquinta, J., and Eynard Bontemps, G.: Pangeo framework for training: experience with FOSS4G, the CLIVAR boot camp and the eScience course, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-8756, https://doi.org/10.5194/egusphere-egu23-8756, 2023;
- Eynard-Bontemps, G., Iaquinta, J., Luna-Valero, S., Caballer, M., Paul, F., Fouilloux, A., Ragan-Kelley, B., Marasco, P. L., and Odaka, T.: Pangeo@EOSC: deployment of PANGEO ecosystem

on the European Open Science Cloud, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-9095, https://doi.org/10.5194/egusphere-egu23-9095, 2023;

- Iaquinta, J. and Fouilloux, A.: Using FAIR and Open Science practices to better understand vegetation browning in Troms and Finnmark (Norway), EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-2579, https://doi.org/10.5194/egusphere-egu23-2579, 2023;

Follow-up activities ensure the publications get more citations and ensure in the longer term the contribution to world-class science.

6.1.2 Strengthening human capital in R&I

C-SCALE has strengthened human capital in Research and Innovation by promoting collaboration and knowledge exchange among researchers, engineers, and experts from various disciplines. The project has provided training, documentation, and support to the scientific community, enabling them to leverage the project's outcomes and develop their own research and innovation activities. By actively involving researchers and professionals in the project's activities, C-SCALE has facilitated the acquisition of new skills, knowledge, and expertise, enhancing the human capital in the field of EO and related domains.

Means of Verification:

- Short term: 11 workshops and tutorials shared on YouTube channel: https://www.youtube.com/@c-scale_project and a project-specific wiki (https://wiki.c-scale.eu/) including documentation and support material from all the relevant areas in the project with an aggregated number of attendees of ca. 100 persons and more than 500 online views (by June 2023).
- On mid and longer terms all partners, Academic (TU Wien), Research Organizations (INFN, Deltares, Vito), EO data and Infrastructure providers (SURF, EGI, EODC, CESNET, GRNET and CloudFerro) are able to leverage the know-how generated at C-SCALE for their training activities and support to researchers.

6.1.3 Fostering diffusion of knowledge and Open Science

C-SCALE has demonstrated a commitment to fostering the diffusion of knowledge and promoting open science principles. This approach encourages the sharing of knowledge, promotes collaboration, and facilitates the replication and further development of the project's outcomes. Through open access to data, tools, and methodologies, C-SCALE has contributed to increasing transparency, reproducibility, and the overall dissemination of scientific knowledge within the research community.

Means of verification:

Short-term: shared knowledge in more than 25 news publications on C-SCALE website https://c-scale.eu/news/.

The project has made its materials, including documentation, workflows, and software, openly available under permissive licenses (i.e. published under CC-BY when possible) and FAIRNESS of data has been a centre point of the project: https://c-scale.eu/about/how-fair-is-c-scale-data/.

On a mid and longer-term new collaborations/transdisciplinary collaborations: Knowledge generated within the use cases has opened new opportunities for follow-up collaborations in cross-disciplinary research - such as the implementation of digital twins for science based on EO workflows developed and that potentially can enrich the large scale Earth digital twin ecosystem fostered under Destination Earth initiative (DestinE).

6.2 Impact on society

6.2.1 Addressing EU policy priorities & global challenges through R&I

C-SCALE has addressed EU policy priorities and global challenges through its research and innovation activities. By leveraging Earth Observation data and technologies, the project has contributed to various societal domains, including environmental monitoring, climate change mitigation, disaster management, and sustainable development. C-SCALE's Key Exploitable Results, such as the FedEarthData service, EO-MQS, openEO Platform, and Workflow Solutions, have the potential to empower policymakers, decision-makers, and stakeholders with valuable information for evidence-based decision-making and policy formulation.

As anticipated, new market opportunities (especially for European SMEs, including micro-enterprises) were fostered by bringing EO applications to EOSC. Thanks to the collaboration with EOSC DIH a number of SMEs have been accessing the C-SCALE services on a test-before-invest approach enabling them to validate their feasibility.

Means of Verification:

8 SMEs have been using C-SCALE generated services (CloudFerro and EODC (from the C-SCALE consortium), and via the open calls: Ubicube, Energy.Family, Tama Group, ITAINNOVA, KappaZetta, BioCarbon, Terradue, NivarIA.

In the mid/longer term, it is expected that the EOSC market will create the necessary niche to incubate and consolidate the services and thereby contribute to the growth of the companies. The capabilities that C-SCALE will facilitate will enable scaling EO-based monitoring of key environmental aspects supporting the implementation of the European Green Deal policies, guiding Europe towards becoming carbon-neutral by 2050.

6.2.2 Delivering benefits & impact via R&I missions

Within the INFRAEOSC07-call[8] description, there were several impacts to be addressed during the execution and as a result of the project. The following section explains briefly how those have been tackled. This will be further expanded in the final progress report.

Scale up the EOSC Portal through a growing catalogue to the broadest possible set of high-quality services and resources supporting the whole research life cycle from service providers across Europe and beyond:

The C-SCALE federation has been established including 8 Cloud, HPC/HTC compute and data providers. Three new services have been onboarded into EOSC Marketplace and main workflows are also available from Zenodo, RoHub and therefore also EOSC.

More scientific communities across Europe are equipped and have access to state-of-the-art services (including storage and computing) for their research activities, increasing data-intensive research:

C-SCALE has provided access to EOSC capabilities to the academic EO research community.

Facilitate Open Science practices across the research community in Europe with services to connect, share and re-use all types of research outputs, fostering collaboration and enhancing scientific discovery.

The project has made its materials, including documentation, workflows, and software, openly available under permissive licenses (i.e. published under CC-BY when possible) and FAIRNESS of data has been a centre point of the project: https://c-scale.eu/about/how-fair-is-c-scale-data/

Support the collaboration in data provision and exchange across regional and national related infrastructures allowing the integration of data from a myriad of resources and research communities:

The combination of FedEarthData and EO-MQS services generated in the project has enabled the discoverability and re-usability of standardized STAC catalogues and EO-based data products together with the necessary infrastructure and tools to analyse and process the data across Europe.

Foster synergies between pan-European e- infrastructures operators, leading to harmonised services, improved use of resources and economies of scale across Europe:

C-SCALE has enabled a common interface for Copernicus/EO datasets and aligned them with other services that are available via the EOSC Marketplace. Merging these previously disconnected service markets and pooling of services and resources on a Pan-European scale bring considerable benefits through network effects (and innovation catalysed by it) and economies of scale factors. For example, through the collaboration with EOSC DIH access European-based SMEs were also able to access the services.

[8] https://cordis.europa.eu/programme/id/H2020_INFRAEOSC-07-2020/en

Coordinate and incentivise institutional and public actors so that they open up their services and resources to researchers across Europe, through a transparent and quality-assured process:

Onboarded services in the EOSC portal ensure high TRL together with high-quality service management/delivery.

6.2.3 Strengthening the uptake of R&I in society

The project has also played a role in strengthening the uptake of research and innovation in society. By providing user-friendly access to Earth Observation data and tools, C-SCALE has enabled a wider range of stakeholders, including researchers, businesses, and citizens, to benefit from EO technologies and applications. Through initiatives like training, workshops, and community engagement, C-SCALE has promoted awareness, knowledge, and the practical utilization of EO data and services across different sectors and societal domains.

Means of verification:

Co-creation activities: 6 initial Use Cases identified at the proposal stage helped to co-design C-SCALE services and make them tailored to the Domain Expert's needs.

Further engagement: 15 additional Use Cases were selected through the Open Call, which provided the experience to kick-start C-SCALE services and create momentum for their uptake.

In the mid-and longer-term all use cases have a very significant impact in terms of societal uptake as they study the impact of climate change, environmental hazards, and agriculture, which are essential to ensure good living conditions & quality of life of European (and world-wide) citizens.

6.3 Impact on economy

6.3.1 Generating innovation-based growth

By developing new services, products, and solutions in the EO domain, the project has created opportunities for commercialization and market development. For example, the FedEarthData service, EO-MQS, openEO Platform, and Workflow Solutions have the potential to meet market demands and address specific needs in sectors such as environmental management, agriculture, urban planning, and disaster response. The project's outcomes have the potential to stimulate economic activity, create more and better jobs, and attract investment in research and innovation within the EO ecosystem.

Means of Verification:

Innovative Results: 5 Key Exploitable Results were generated - including the definition of 3 services and 4 main workflow solutions and many others to be leveraged resulting from the 15 external use cases. Sustainability for all the Key Exploitable Results has been granted including commitment from core organisations (KER owners) and infrastructure and technology providers.

In the mid-and longer-term, economic growth can be fostered by the expansion of the services among potential users, which opens the opportunity to follow up the research and development activities, but also opens the opportunity for SMEs and industry to make use of the platforms, and public authorities for evidence-based policymaking.

6.3.2 Creating more and better jobs

Supported employment: During the C-SCALE project, ca. 80 people among researchers, engineers and support teams have been involved in the project. The project's follow-up activities have been strategically designed to ensure the continued employment of these individuals within each participating organisation.

In the mid-and longer-term, take-up activities can foster the creation of new jobs as the usage of the services increase and further business and follow-up research opportunities emerge.

6.3.3 Leveraging investments in R&I

Co-Investment: By the end of C-SCALE, some of the use cases and activities are further developed under other follow-up projects & activities (such as the Horizon Europe interTwin project, the ESA-funded openEO platform and the INTERFACE project (enabled with national funding) and can potentially scale up in Destination Earth related digital twins. Altogether they represent an aggregated complementary direct funding of several 100k €.

6.4 Success stories

Table 8: Success stories

Success Story	Scientific Impact	Societal Impact	Economic Impact
SAR on the fly[9]	Scientific advancements in land subsidence monitoring, infrastructure stability assessment, and land cover classification.	Improved disaster preparedness, urban planning, and infrastructure management.	Identification of high-risk areas for land subsidence preventior and optimised land management decisions.

[9] https://medium.com/@gglemoine62/12-day-sentinel-1-coherence-a-test-case-for-ukraine-998488bf589

WaterWatch[10]	Derive water surface dynamics from EO data for an improved understanding of water resources and climate risks.	Support response to climate risks, optimised water usage, and reduced socio-economic impacts of water-related disasters.	Reduced impact associated with water-related risks and improved water management strategies.
Aquamonitor[11]	Quantify land-surface changes due to man-made interventions, natural variability, and climate change.	Enhanced preparedness for climate change impacts.	Support decision-making and sustainable development.
HiSea[12]	High-resolution model data for improved understanding of coastal ocean dynamics and water quality.	Increased safety, efficiency, and sustainability in port operations and aquaculture activities.	Improved economic performance of ports and aquaculture industries through optimised operations and reduced risks.
LSDA[13]	Ensemble river discharge forecasts for rivers for an improved understanding of forecast accuracy.	Improved river monitoring, flood forecasting, and water resource management.	Minimised flood damages, optimised water resource allocation, and increased efficiency in river-related industries.

[10] https://c-scale.eu/interoperable-services-enabling-timely-response-to-climate-related-risks/

[11] https://c-scale.eu/unlocking-global-satellite-data-with-openeo/

[12] https://c-scale.eu/supporting-ports-and-aquaculture-industries/

[13] https://c-scale.eu/towards-automated-ensemble-discharge-forecasts-for-any-river-in-the-world-on-a-federated-compute-and-data-infrastructure/

7 Conclusions and Discussion

7.1 Conclusions

C-SCALE project has achieved the creation of the C-SCALE Compute and Data Federation along with the necessary service catalogue to exploit the infrastructure capabilities for streamlining the discoverability of Copernicus-based and other related Earth Observation data and providing the necessary compute capabilities and tools in order to access, analyse and create value from it. This deliverable has expanded the technical blueprint derived from D5.4 and describes the Key Exploitable Results and the efforts undertaken during the project in order to further define the services and its blueprints and cover the necessary steps to ensure the exploitation of those and the sustainability after the project. The following figure summarises the different aspects of each of the KERs as it has been described along D5.5.

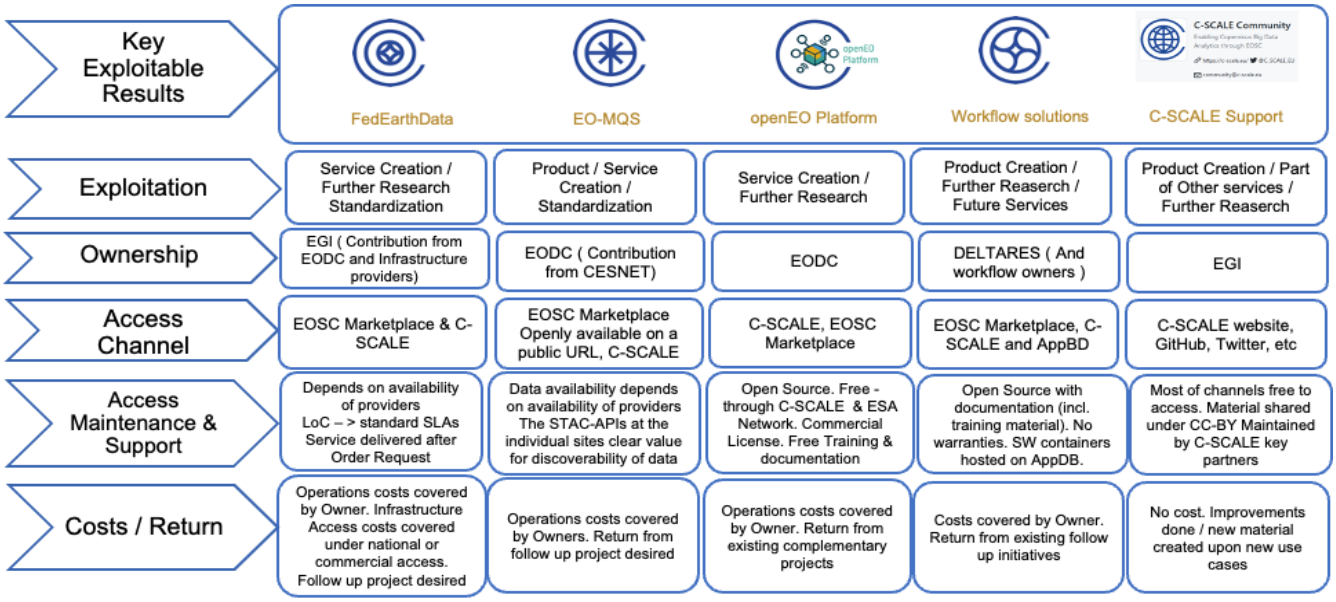


Figure 12: Summary figure of C-SCALE KERs, Exploitation and Sustainability Aspects

7.2 Discussion

Given those results, it is worth highlighting how those have contributed to the evolving European earth observation landscape:

Before C-SCALE:

In 2014, a significant milestone was achieved with the launch of Sentinel-1, a satellite mission under the Copernicus program. This marked the beginning of operational data provision in 2015. Sentinel-1, along with subsequent Sentinel satellites, provides continuous monitoring of Earth's surface and atmosphere, generating valuable data for various applications.

Also in 2014, the Copernicus Open Access Hub, initially known as SciHub,[14] was established. This hub was conceived as a central platform for accessing and downloading Copernicus data and products providing free and open access to Earth Observation data for users across various domains.

In 2016, the concept of Sentinels National Mirrors and ESA Data Hub Relays was introduced. These mirrors and relays served as distributed platforms for accessing and disseminating Sentinel-generated data. They aimed to improve data accessibility.

In 2018, five contracts were awarded to establish a self-sustainable Copernicus Data and Information Access Service (DIAS).[15] These DIAS platforms provided advanced tools and services for processing, analysing, and visualising Copernicus data. They enabled users to harness the full potential of the available data and develop innovative applications.

The year 2018 also saw the inception of WEkEO, a federation concept by EUMETSAT[16]. WEkEO aims to harmonise data access across multiple Earth Observation data providers, allowing users to access and utilise data seamlessly from different sources. It facilitates cross-domain research and collaboration.

In 2019, the European Space Agency (ESA) introduced the Network of Resources (NoR)[17]. The NoR serves as a platform to discover and access a wide range of Earth Observation resources, including data, tools, services, and expertise. It promotes networking, knowledge exchange, and collaboration among the Earth Observation community.

All those initiatives along with C-SCALE contribute to streamlining the process from data discoverability to the necessary analysis has contributed to widening the use of Sentinel-generated data.

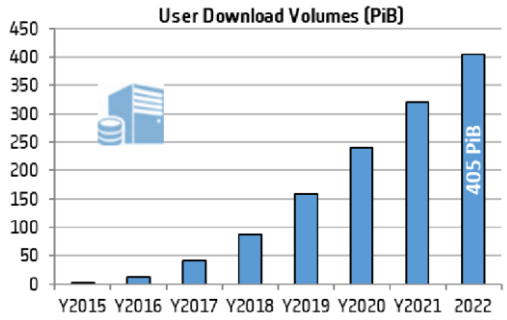


Figure 13: Copernicus Sentinel Data Access Annual Report 2022[18]

[14] https://scihub.copernicus.eu/

[15] https://www.copernicus.eu/en/access-data/dias

[16] https://www.eumetsat.int/who-we-work/wekeo

[17] https://eo4society.esa.int/network-of-resources/nor-sponsorship/, https://nor-discover.org/

[18] https://scihub.copernicus.eu/twiki/pub/SciHubWebPortal/AnnualReport2022/COPE-SERCO-RP-23-1493_SentinelDataAccessAnnual_Report_2022_final.pdf

After C-SCALE:

After C-SCALE many of the activities that had been set up have been replaced by new services or evolved into different ones. Thereby, the support for DIAS via ESA stopped and Copernicus Open Access Hub is expected to be discontinued. Only WEkEO DIAS is kept operational. Instead, Copernicus Data Access Service[19] a new solution linked to EU data spaces is being promoted as the central access point.
On top of the services, the European Commission (EC) has launched the Destination Earth initiative[20], aiming to enhance Earth Observation capabilities and develop a comprehensive, integrated approach to monitoring and understand Earth's systems and dynamics. Activities and services included as part of the initiative are:

- Data Lake (EUMETSAT): a centralised and scalable repository for storing and managing vast amounts of Earth Observation data in order to facilitate more efficient data access and use.
- Core Service Platform (ESA), offering a range of essential services and tools for Earth Observation data processing, analysis, and dissemination.
- Digital Twins (ECMWF) starting with (1) Weather-Induced and Geophysical Extremes and (2) Climate Change Adaptation, aimed to create virtual representations of Earth's systems for better understanding and forecasting.

All those offer continued opportunities for C-SCALE to keep on delivering impact after the end of the project. As such -major contributions from the C-SCALE project include the creation of major services:

- FedEarthData & Earth Observation Metadata Query Service which includes a Data catalogue based on STAC - which is now widely used in EO-related services along with the data federation. All know-how generated will contribute to the current federation ideas in Destination Earth, Data spaces, etc.
- openEO Platform: will remain as a federated service offering available both for research and for commercial purposes.
- Know-how on Infrastructure as a Service (IaaS) Federation includes the federation of OpenStack-based Infrastructure-as-a-Service cloud providers and federation of SLURM-based High-Throughput Compute (HTC) and High-Performance Compute (HPC) providers. This will enable to optimise heterogeneous computing resources depending on the necessary workloads.
- Workflow Solutions (openEO) have provided reusable algorithms and workflows for science and practical applications that can further evolve into high-societal impact services in the future.
- Finally, all support material generated, including tutorials, and workshops will remain available for future users.

[19] https://dataspace.copernicus.eu/

[20] https://digital-strategy.ec.europa.eu/en/policies/destination-earth

Annex1: FedEarthData - Federation Status

Service Provider	Federated Cloud	Federated HTC/HPC	Federated Notebooks	Federated openEO	Federated Data Provider	Letter of Commitment	Baseline SLAs
CESNET	Yes	N/A	Yes	back-end only	Yes	Yes	EGI SLA[21]
CreoDIAS	Yes	N/A	N/A	Yes	Yes	Yes	ESA NoR[22]
EODC	Yes	Yes	Yes	Yes	Yes	Yes	ESA NoR
GRNET	Yes	Yes	N/A	N/A	Yes	Yes	EGI SLA
INCD	Yes	N/A	N/A	back-end only	N/A	Yes	EGI SLA
INFN	Yes	N/A	N/A	back-end only	N/A	Ongoing	EGI SLA
SURF	N/A	Yes	N/A	N/A	N/A	Yes	EGI SLA
VITO	N/A	N/A	Yes	Yes	Yes	Yes	ESA NoR

[21] https://documents.egi.eu/document/2733

[22] https://nor-discover.org

Annex 2: Letter of Commitment relating to the continuous support of the FedEarthData service after the project termination

Undertaken by:

[Company name],{short name], established in [street], [City] [postal code], [country], [VAT number, hereafter the 'Party',

Herein validly represented by [person name], in his/her legal capacity as Partner-Manager,

Having regard to the following:

- The Party participated as a partner in the Copernicus – eoSC AnaLytics Engine (hereafter 'C-SCALE', a project that has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 101017529, to which the Party was a signatory.
- The C-SCALE data & compute resources of the party have been technically integrated into the EGI federation and therefore the party is able to provide those services via EOSC.
- C-SCALE has successfully developed the *Federated Earth System Simulation and Data Processing Platform* service (hereafter 'FedEarthData', see Annexes), which has clear market and business potential, and which can be further promoted/developed exploited beyond C-SCALE's date of termination as set out in accordance with the Grant Agreement. A first version of the service description, service management, access & privacy policy and terms of use have been described and included in the Annexes.
- Based on this opportunity, the Party is willing and intends to provide further support as described in this Letter of Intent to the exploitation of FedEarthData.

Therefore, the Party declares as follows:

Commitment of the Party

The Party shall make available necessary resources under fair and reasonable conditions, in accordance with C-SCALE's market and business potential as assessed by the Party, in order to support the exploitation of FedEarthData in the following use cases:

- Use cases already identified in the C-SCALE description of action, as follow-up and extensions of project activities.
- Use cases originated through the EOSC Marketplace business channel.
- Use cases originated by the EOSC DIH and EGI DIH involving SMEs.

Upon service provision request, a proper Virtual Access agreement (VA) or Operation Level Agreement (OLA) will be signed with corresponding parties - based on the process and agreements defined for the use cases during the project (as included in the Annex)

The Party commits to collaborate with other partners participating in the delivery of components of the FedEarthData service to:

- Jointly support the successful adoption of the Service by user communities.
- Guarantee availability of the service components supplied by the Party as listed in the annex.
- Promote the service to target groups with the aim of jointly pursuing business opportunities wherever this is necessary and beneficial to the Party to realise C-SCALE's market and business potential. This will be reflected in a Memorandum of Understanding to be defined before the end of the project.

For the avoidance of doubt, this Letter of Commitment is limited to what is stated explicitly herein. This Letter of Commitment does not create any legal undertaking, consortium, formal partnership or joint venture, nor does it result in any agency or grant any power of representation to any party. This Letter of Commitment does not give rise to any transfers of property rights (including intellectual property rights), nor any grants of licences or permissions, and it does not replace or affect in any way any legal agreements to which the Party is a signatory. This Letter of Commitment does not grant any exclusivity rights and does not constitute a binding legal obligation in the absence of further agreements to ensure the involvement of other parties before acting on any business or market opportunity in relation to C-SCALE.

Duration and validity of this Letter of Intent

The Party shall make the necessary resources available under fair and reasonable conditions in order to make good on its intent as described above after the date of termination of C-SCALE, and it shall act in accordance with this Letter of Commitment, for a period of time which it deems to be useful in order to conclusively determine C-SCALE's market and business potential to its own satisfaction.

Without formal commitment on this exact duration, the Party's best efforts estimation of this period of time is presently a period of 4 years after C-SCALE's date of termination as set out in accordance with the Grant Agreement.

Signed on [date month], in [city], by [person name]

[Signature and/or company stamp]

Letter of Commitment Annexes

EOSC Service Onboarding Resource Profile

See: https://confluence.egi.eu/display/CSCALE/FedEarthData%3A+Federated+Earth+System+Simulation+and+Data+Processing+Platform (Restricted)

Service Description

See: https://marketplace.eosc-portal.eu/services/eosc.egi-fed.fedearthdata (Restricted)

Service Management

See: https://confluence.egi.eu/display/CSCALE/Service+Management+for+FedEarthData (Restricted)

Access Policy

See: https://wiki.c-scale.eu/C-SCALE/c-scale-services/fedearthdata/fedearthdata-access-policy (Restricted)

Privacy Policy

See: https://wiki.c-scale.eu/C-SCALE/c-scale-services/fedearthdata/fedearthdata-privacy-policy (Restricted)

Terms of use

See: https://wiki.c-scale.eu/C-SCALE/c-scale-services/fedearthdata/fedearthdata-tou (Restricted)

PROC01 to set up Virtual Access Agreements

See: https://confluence.egi.eu/display/CSCALE/PROC01+-+Creation%2C+update+and+review+of+VA+Agreements (Restricted)

Service Provider Status:

See: https://confluence.egi.eu/display/CSCALE/Service+provider+status (Restricted)