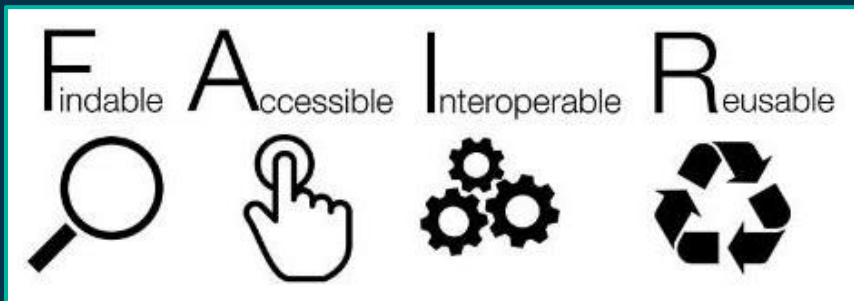


EO Platforms and Services for Earth Action – enabling sustainable science and applications in a cloud- based federated ecosystem

CCI colocation meeting, 25 March 2026
Anca Anghela & Patrick Griffiths
Digital Innovation Section, EOP-SGD

Earth Action & Digital Innovation

- **Earth Action** is grouping several program elements under a single pillar: EO4Society & Phi-lab, Climate Space, Global Development Assistance
- Transversal elements in Earth Action include **Digital Enablement & Disruptive Innovation**



- ESA EO **Digital Innovation Strategy** transforms Science into Societal Benefits via cloud-based Collaboration, Sharing and Production Environments
- This needs to be enabled by a **FAIR compliant ecosystem** of EO platforms and other digital resources

Earth Action: turning Science into Services for Society



EarthCODE – Build FAIR Science

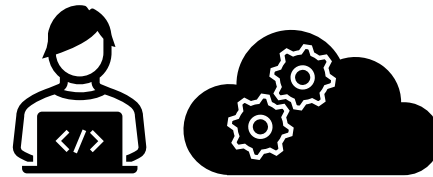
Guides and supports scientists to develop FAIR scientific products and algorithms.



- Enables reproducible, FAIR EO workflows and data products
- Provides data & workflow engineering on cloud platforms
- Establishes a long-term, accessible knowledge base

APEX – Operationalise & Scale

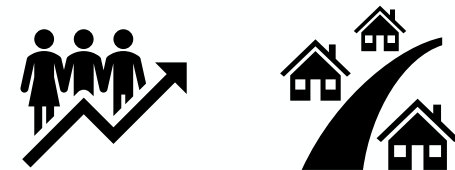
Builds on FAIR compliance to propagate EO Applications and cloud-based services.



- Ensures FAIR compliance of EO applications and services
- Promotes interoperability across platforms & communities
- Turns R&D algorithms into cloud-based on-demand services

Information Factories – Deliver Value

Builds on cloud-based services to deliver actionable insights useable by stakeholders.



- Converts EO services into actionable insights
- Integrates outputs into decision-making workflows
- Enables uptake in commercial and policy markets

Knowledge Development

TRL 1 – 3: Basic research – research to prove feasibility

Technology Development

TRL 4 – 6: Tech. demonstration – prototype development

Business Development

TRL 7 – 9: Pilot & scale up – Market launch & commercialisation

What is EarthCODE ?

A strategic ESA initiative to provide scientists with skills, means and tools to adopt FAIR Open Science

FAIR = **F**indable, **A**ccessible, **I**nteroperable, **R**eusable

Who are the users?

ESA-Funded Research and ESA collaborative initiatives (e.g., ESA-RTD Earth System Science Initiative)

Who implements EarthCODE?

An ecosystem of platforms and service providers that implement the same interoperability standards

Providers selected in open competition, via yearly Best Practice Procurements

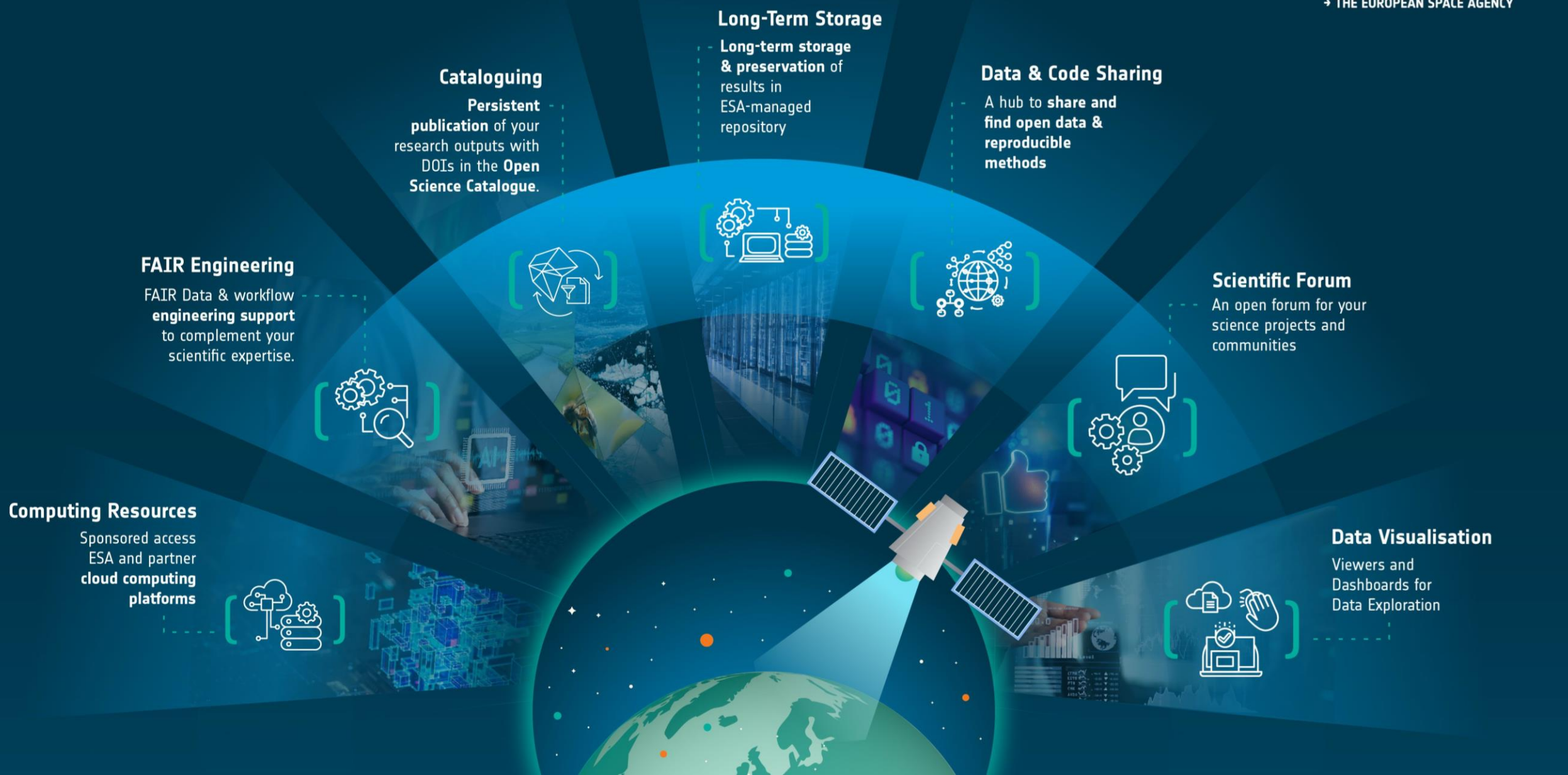


+NOR Providers

+National Infrastructures

+Other partners

What does EarthCODE offer ?

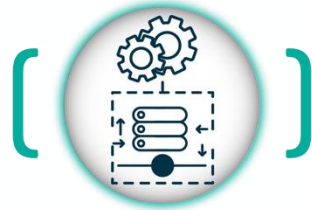


EarthCODE Services to support Science Projects



Run workflows on platforms

Seamless access to an expanding ecosystem of cloud-based Earth Observation platforms. No setup needed.



Data & workflow engineering support

Get support to transform the data into cloud-optimized formats, and FAIR-ify data and workflows.



Publishing scientific experiments

Upload data, workflows, and results. Make them reproducible and citable.



Discover & Reuse

Search and filter through published science assets. Use in local or cloud environment.



Visualisation of the results

Built-in tools and dashboards to plot, compare, and share geospatial outputs.



Community Forum

Join discussions, ask questions, and exchange best practice.



EarthCODE Services to support Science Projects



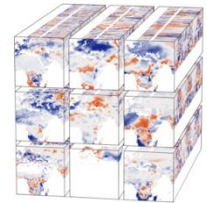
Data & workflow engineering support

Get support to transform the data into cloud-optimized formats, and FAIR-ify data and workflows.



2 flavours

1. FAIR Engineering Service –
Specialised Data & Workflow Engineering support to complement your project's science team

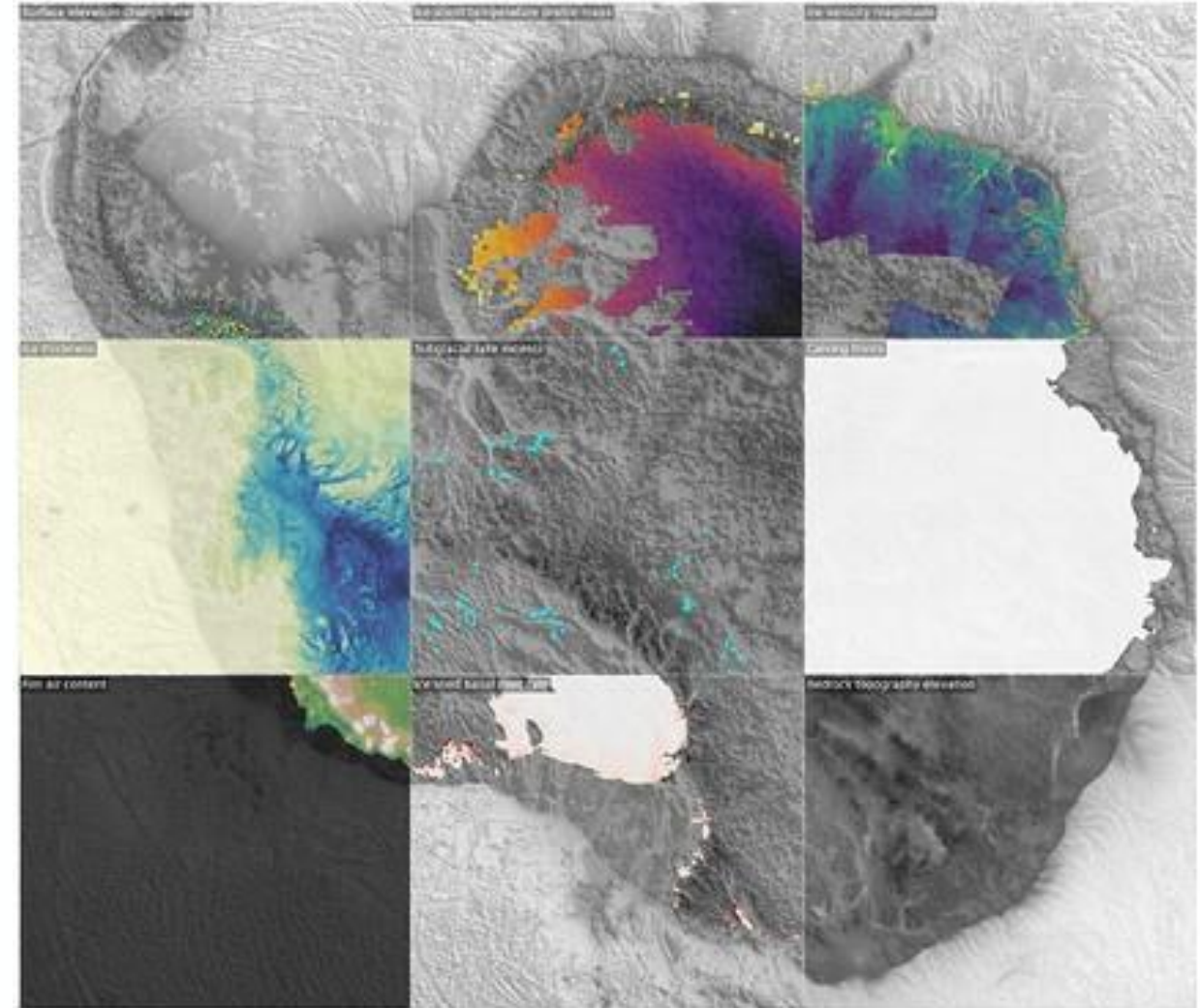
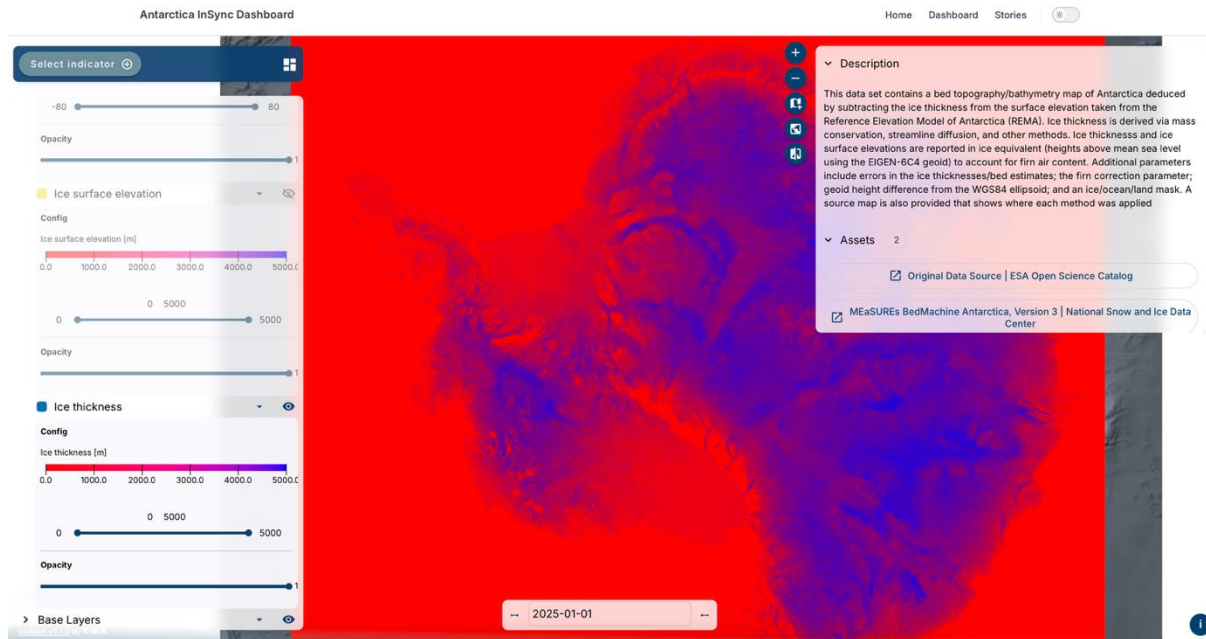


2. Scientific Data Update Service –
continuously update scientific data products using automated, mature workflows



https://s3.waw4-1.cloudferro.com/EarthCODE/OSCAAssets/antarctica_cube/antarctica-combined.zarr

- Bedrock topography
- Ice shelf Basal Melt
- Groundlines
- Subglacial Lakes
- Supraglacial Lakes
- https://s3.waw4-1.cloudferro.com/EarthCODE/OSCAAssets/antarctica_cube/icetemp.zarr
 - Ice Temperature Profiles
- https://s3.waw4-1.cloudferro.com/EarthCODE/OSCAAssets/antarctica_cube/sec.zarr
 - Surface Elevation Change
- https://s3.waw4-1.cloudferro.com/EarthCODE/OSCAAssets/antarctica_cube/icemask_composite.zarr/
 - Calving Fronts
- https://s3.waw4-1.cloudferro.com/EarthCODE/OSCAAssets/antarctica_cube/ice_velocity.zarr
 - Ice Velocity 2020-2021



What is APEX?

Application Propagation Environments (APEX)

An EOP strategic initiative to promote FAIR compliance for EO applications and cloud-based services.

Who are the users?

APEX supports ESA projects, the larger EO community and EO value-adding industry.

Who implements APEX?

The main APEX services and solutions are developed by a core consortium.

APEX seeks to support an open federation of EO platforms, value-adders and (operational) users.

Consortium:



Federated platforms:



EO value-adders:

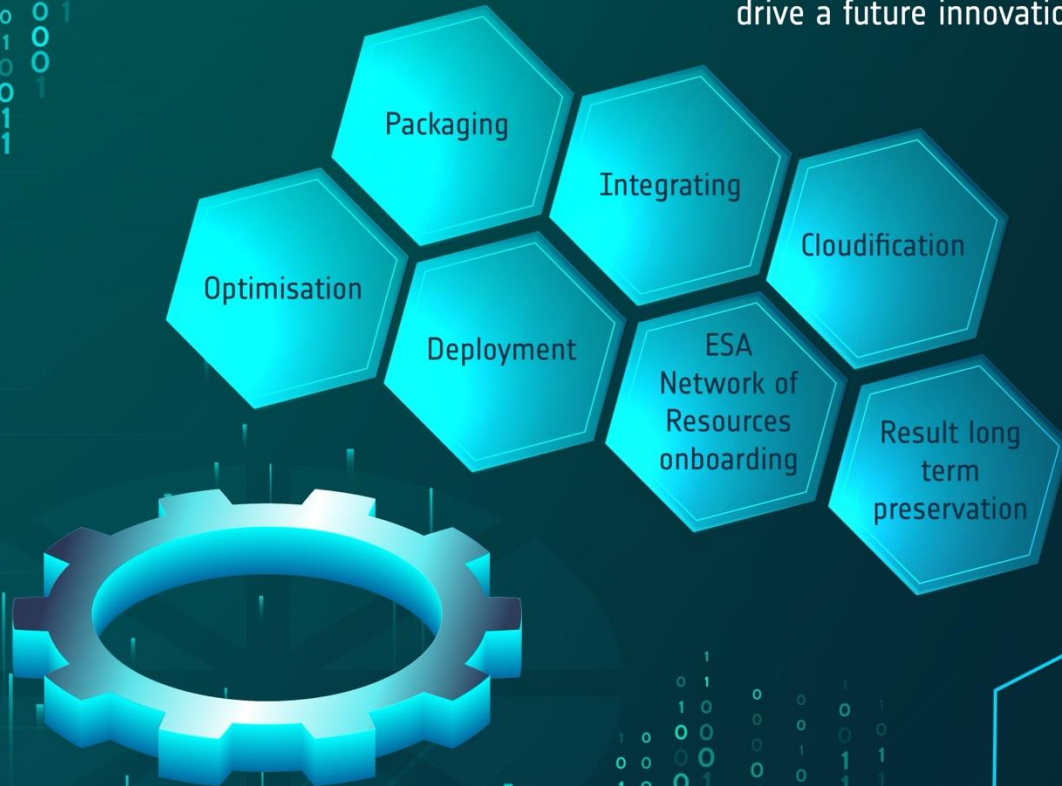


<https://apex.esa.int/>

What does APEX offer?

ALGORITHM SERVICES

APEX provides custom support to preserve, enhance, and transform project outcomes into scalable, reusable services, ensuring they remain impactful and drive a future innovation.



PROJECT TOOLS

APEX provides project cloud based project development environment, consisting of various components that are deployed in the cloud on demand and that are tailored in look and feel to match the project context.




ESA Project Result Repository (PRR)

- ✓ Open data repository on ESA Cloud ensuring long-term accessibility of higher-level, value-added products
- ✓ EOP-S curated and operated, serving Earth Action vision, driven by APEX and EarthCODE
- ✓ Products accessible publicly via [STAC catalogue](#)
- ✓ Requirement for *cloud-native* data formats and specifications: https://eoresults.esa.int/prr_faq.html

Relevance for Earth Action:

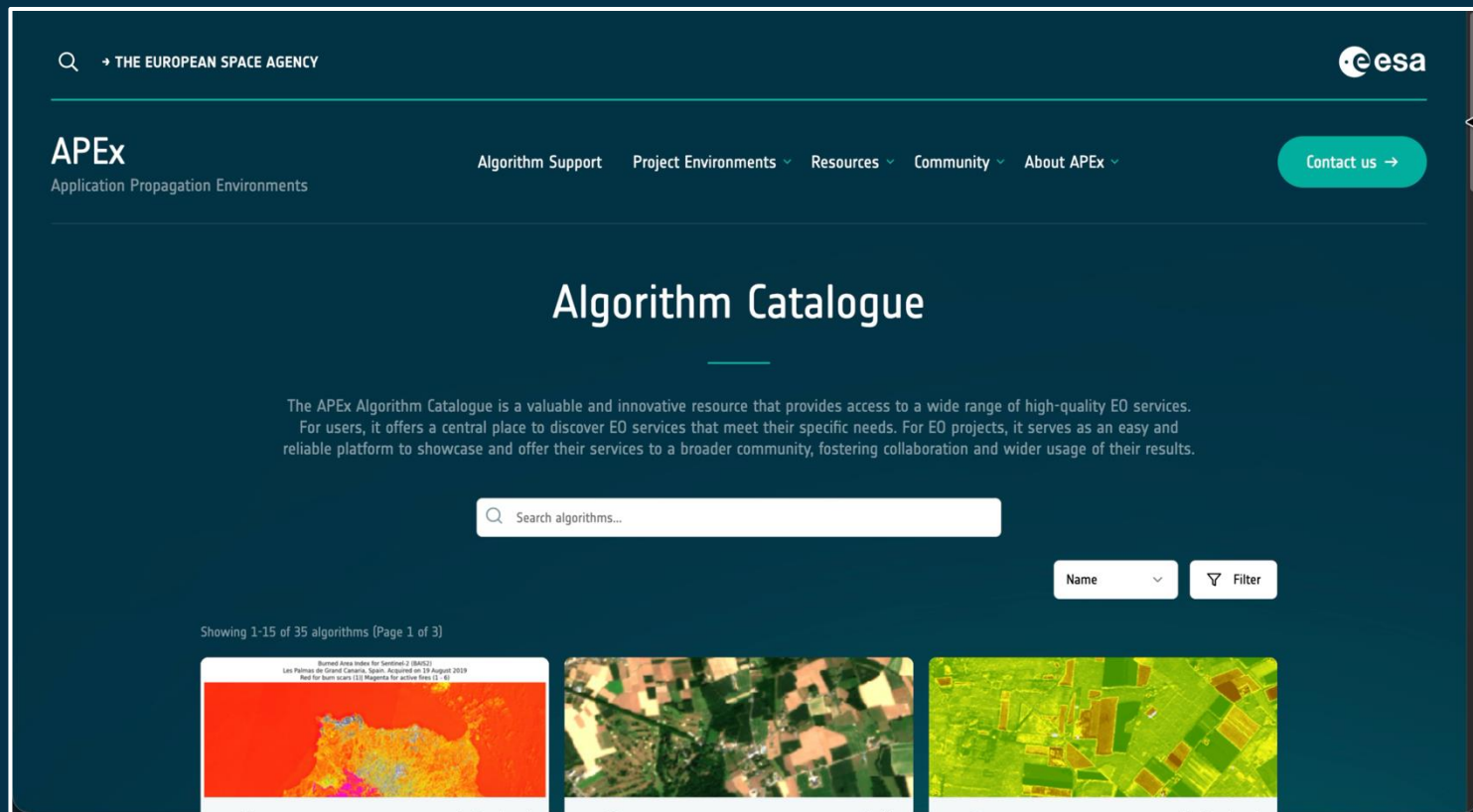
- + “Streaming access” to EOP-S value-added products
- + Centralised long-term preservation of project results

APEX Algorithm Catalogue

- ✓ Curated collection of executable and FAIR compliant on-demand algorithms deployed on federated EO platforms
- ✓ Algorithms implemented as openEO User Defined Process (UDP) or EO Application Packages (EOAP)
- ✓ Routine benchmark tests to monitor algorithm availability & functioning 

Relevance for Earth Action:

- + Discover and reuse value-adding solutions
- + Promote adoption & uptake of algorithms
- + Compatibility with APEX productivity tools e.g. for upscaling or systematic processing



<https://algorithm-catalogue.apex.esa.int/>

APEX Geospatial Explorer – build your own showcase



ESA APEX Geospatial Explorer
Configuration Builder
Build and manage your interactive mapping application configuration

Project: Geospatial Explorer - Custom Config

Version: 1.0.0

Interface Groups: 3 | Layers: 4 | Base Layers: 15 | Exclusivity Sets: 0 | Services: 13

Layer QA: Complete Layers: 4 | Missing Legend: 4 | Missing Style: 4 | No Stats/Statistics: 0

Last loaded: 11/05/2023, 10:58:09 AM
Last exported: 11/05/2023, 10:55:36 AM

Export and share configuration file

Project: Geospatial Explorer

Version: 1.0.0

Interface Groups: 3 | Layers: 4 | Base Layers: 15 | Exclusivity Sets: 0 | Services: 13

Last loaded: 11/05/2023, 10:58:09 AM
Last exported: 11/05/2023, 11:05:22 AM

Set-up interactive execution of on-demand algorithms

Efficient Fusion Algorithm across Spatio-Temporal scales (EFAST)

OVERVIEW

EFAST (1) is a method to fuse spatial and time series from a high-resolution source (Sentinel-2) and a low-resolution source (Sentinel-3). In this case, the method is used to fuse the vegetation indices from Sentinel-2 and Sentinel-3. The method achieves results outperforming single-source interpolation without paying the computational cost of other methods leveraging spatial context. [1] Senth, Paul, Radoslaw Guzikowski, Kenneth Gagan, et al. "Fast Fusion of Sentinel-2 and Sentinel-3 Time Series over Rangelands." Remote Sensing 16, no. 11 (2024): 1893.

TAGS: Sentinel-2, Sentinel-3, Data Analysis and Visualization, Normalized Difference Vegetation Index (NDVI)

Execute Algorithm

Configure parameters and submit job

START DATE: 01/03/2025 | END DATE: 01/08/2025

TEMPORAL_EXTENT_TARGET

Set logos, colour maps, fonts, default extent and zoom levels

Settings

Navigation Settings

Quick Location: Custom (Manual Entry)

Map centre at start: Latitude: Longitude:

Logos: ESA

Colour Scheme

Background: #002060 | Font: #FFFFFF | Panel: #333333

File & Level 1 menu: #002060 | Level 2 menu: #001010 | Panel: #333333

Reset to default

Define interface groups and map layers along with attribution and layer styling

Map Layers

Configure your map layers organized by interface groups. Total: 15 layers

World Soil | Home | Add Layer

Soil Organic Carbon

Legend - gradient

ColorMap: 14,400 (SR maps)

Data Sources

COG: europe_app.org_08_032_cms_100_20203_20220.tif | WMS: WORLDCOVER_2021_L2_FCC

APEX - Demo Geospatial Explorer

openEO Results

openEO Job - PV Farm Mapping

Comparisons

Sentinel 2 vs World Cover 2021

Time Series

Soil Water Index - Daily WMTS

Fraction of Green Vegetation Cover - 10 Daily WMTS

Crop Type - Level 3 - Multiple COGs

Statistics

World Cover 2021 with NUTS Statistics

World Cover 2021 with N2K Statistics

Habitat Map GR Level 1 2020 with NUTS Statistics

Habitat Map GR Level 1 2020 with NUTS Statistics without Base Layer

Topsoil Soil Organic Carbon 2020-22 with NUTS Statistics

Layer Constraints

Topsoil Soil Organic Carbon - 2018 to 2022

Source: ESA WorldSoils

Austria Annual Solar Power Potential

Resource Linking

9,7506, 47,6402

Zoom To Start Location

Share your showcase with your community!

Topsoil Soil Organic Carbon - 2018 to 2022

dg kg⁻¹

50% | 1800

Land Cover Types (from World Cover 2022)

10 of 10 categories selected

Uncertainty (Index)

1 | 100

Overview | Data Values

Soil Organic Carbon content in the 0-20 cm top soil expressed in g kg⁻¹ for 100 m resolution pixels with constraint layer from World Cover. Time series dates indicate the end of the two year period over which the data is measured i.e. 2020 (2019 to 2020), 2021 (2019 to 2021), 2022 (2020 to 2022)

Data source: ESA WorldSoils

0 dg kg⁻¹ | 1800 dg kg⁻¹

Configured Services

Configure WMTS, WMS, and STAC services that can be used across multiple data sources. Services support automatic discovery via GPT/Catalogue, bucket listing, or catalogue metadata.

Project Results Repository (STAC) | WYTO STAC Catalogue (STAC) | Brockmann Kubler (WMS) | CLMS WMS Server (WMS) | openeio N2K 2006 (WMS)

Above Ground Biomass

Above ground biomass (AGB) is the total mass of all living vegetation above the soil, including the stems, branches, bark, foliage, and seeds.

Attribution

Source: Forest Carbon

URL: https://www.esa.int/en/esa_family/esa/forest_carbon

ColorMaps

Legend - gradient

Controls

Toggleable | Zoom to Center | Opacity Slider

Data Sources

COG: FCM_Europe_demo_2023_AGB.tif

Configure interactive tools

Controls

Toggleable | Zoom to Center | Opacity Slider | Constraint Slider

Data Sources

Datasets (1) | Statistics (0) | Constraints (1) | Workflows (0) | Charts (0)

COG: 2024_LST_AT_merged_composite_mean_70m.tif

LST Interactive | Continuous | Min: 0 | Max: 100 | Units: C

+ Add Constraint Source

Select datasets from custom and preconfigured repositories and services

ESA LUISA - Continental HANPP_HARV_BANGLAND products for Africa at 1km resolution

ESA LUISA - Continental HANPP_HARV_BANGLAND products at 1km resolution for the African continent from 2000-2020

ESA LUISA - Continental HANPP_HARV_BANGLAND products at 1km resolution for the African continent from 2000-2020

ESA LUISA - Continental HANPP_HARV_BANGLAND products at 1km resolution for the African continent from 2000-2020

Ecosystem Coastal Condition Accounts

Ecosystem Extent Accounts

Ecosystem Habitat Maps (EUNIS 2012)

<https://apex-ge-config-builder.sparkgeo.uk/>

Information Factory Vision

The "Last Km" Challenge

- **Technical:** fragmentation in the EO value-adding community, linking EO and non-EO products, integrating solutions within end-user workflows, processes and IS
- **Business & operations:** fitness-for-purpose, scaling mechanisms, business & partnership models, governance etc

Who are the users of an IF?

The IF brings together several actors from the service production and consumption value chain including:



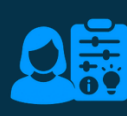
Data Owners



Value-adders



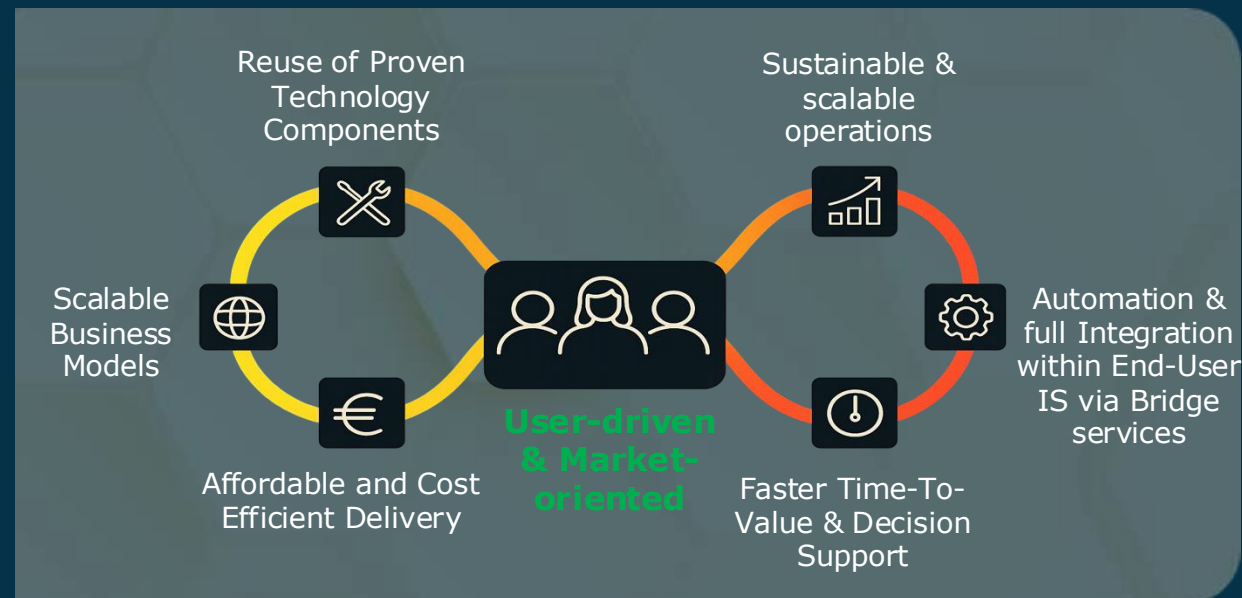
System Integrators



End-users/
stakeholders

What is an Information Factory (IF)?

A commercially operated ecosystem of scalable and cost-efficient cloud capabilities, services, technical & business tools, facilitating the customization and integration of EO solutions addressing stakeholder needs and supporting their decision-making and operational processes



Information Factory ongoing activities: *IF Pathfinders for Adaptation*

IF Urban



- Technical implementation based on TAO platform and xcube services
- Geographic focus: Germany
- Anchor stakeholders include Firefighters Düsseldorf, LGV Hamburg and City of Berlin
- Urban resilience domain

Climate Resilience & Emergency Response for Real-Time Urban Situational Awareness Platform

Climate-Smart Cities & Infrastructure

Climate Risk Insights & Mitigation

Climate-resilient food systems

Ubiverde IF



- Technical implementation based on EOEPKA components
- Geographic focus: France
- Anchor stakeholders include Cities of Perpignan, Nancy, La Roche-sur-Yon and Kourou
- Urban resilience domain:

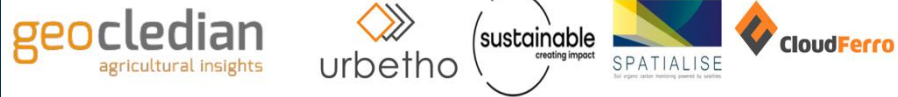
Service tiers 1 – Observation and key urban Indicators (e.g. Vegetation mapping, Air Quality etc)

Service tiers 2 – Ecosystem services

Service tiers 3 – Climate impact and projections

Information Factory ongoing activities: *IF Pathfinders for Adaptation*

Climate Smart Agriculture IF



- Technical implementation based on Creodias
- Geographic focus: initial focus on Europe (Germany), potential global applicability
- Anchor stakeholders include MyEasyFarm, CrowdFarming, Opterra and Allianz Agrar AG
- Adaptive agriculture domain:

Climate Resilient Farming

Carbon Farming

Hazard assessment and monitoring

Climate Adaptive Seed Production

ADAPTA-IF



- Technical implementation based on EOEPKA components
- Geographic focus: Africa, Asia, Europe
- Anchor stakeholders include CABI and CottonConnect
- Adaptive Agriculture Domain:

Production Risk for the Cotton Supply Chain

Maize Yield Optimization in Kenya

Better Decisions for Olive Farms in Cyprus

Dutch IF



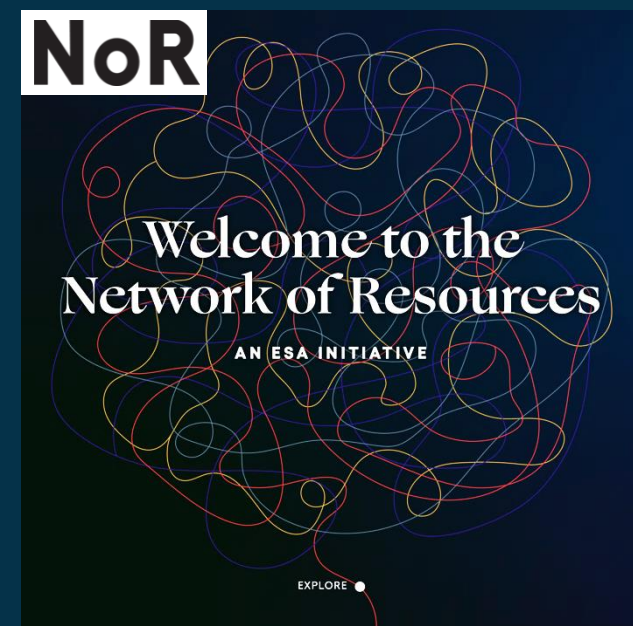
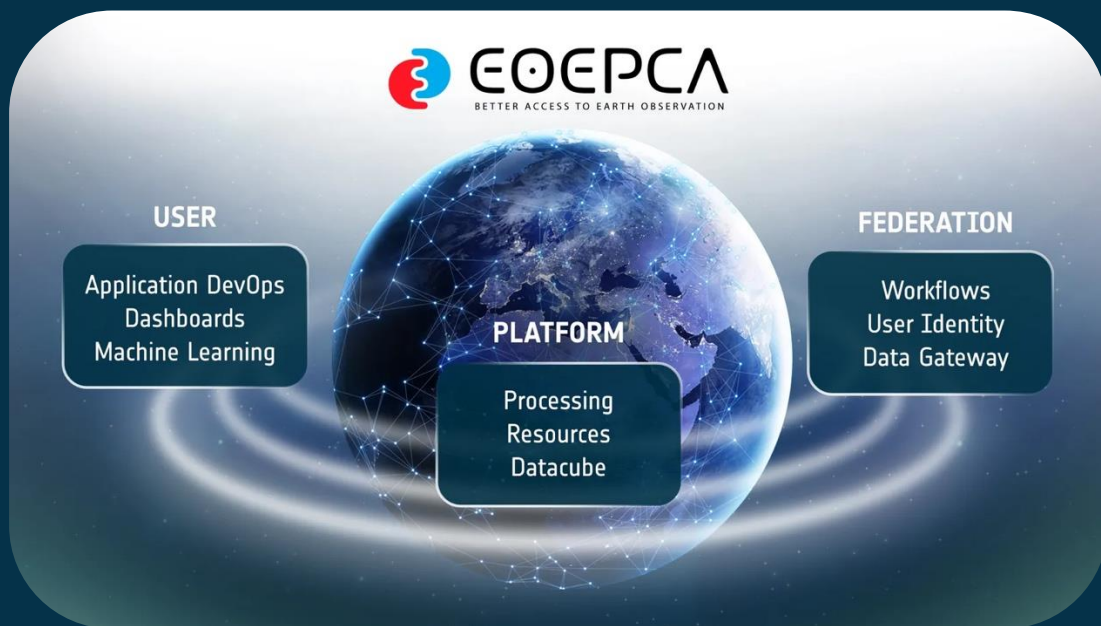
- Technical implementation based on Ellipsis Drive Proprietary Platform
- Geographic focus: NL & BE
- Anchor stakeholders include the city of Almere (NL), Rabobank and Province of Drenthe
- Urban resilience / adaptive agriculture:

Financing Climate-Resilient Agriculture in Dutch Provinces

Monitoring Agricultural buffer strips for Water Quality and Biodiversity

Supporting Cities in Sustainable Energy and Climate Action Planning

Digital Innovation - Transversal elements



EOEPCA+ (EO Exploitation Platform Common Architecture):

- Reusable (software) building blocks ensuring interoperability between EO platforms
- Large open-source community participation and uptake
- www.eoepca.org

NOR (Network of Resources):

- Portfolio of European EO platform services
- Sponsorship mechanism to support uptake and derisking
- EarthCODE & APEx services are offered via NoR
- <https://nor-discover.org>

Conclusion: Digital Innovation & Earth Action

- The presented initiatives support EO projects and scientists at different stages on the EO value chain
- A key objective of the Digital Innovation strategy is to enable an **ecosystem of FAIR compliant solutions** in support of Earth Action
- Today was just a brief introduction - a **dedicated webinar** for the CCI/Climate Space community will be organised to introduce the initiatives and related engagement opportunities in more detail