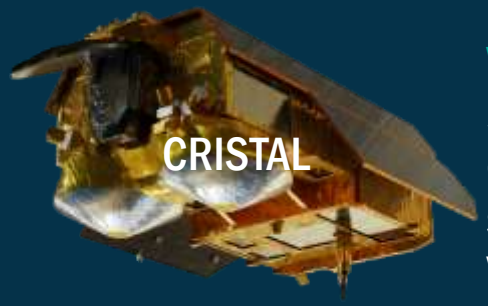
ESA Sentinel User Preparation initiative and upcoming Fixed Call for Proposal

EOP-SG

19/01/2024

Sentinel Users Preparation (SUP) ESA EOP Initiative

Activity in collaborative synergy with the EC



WHAT

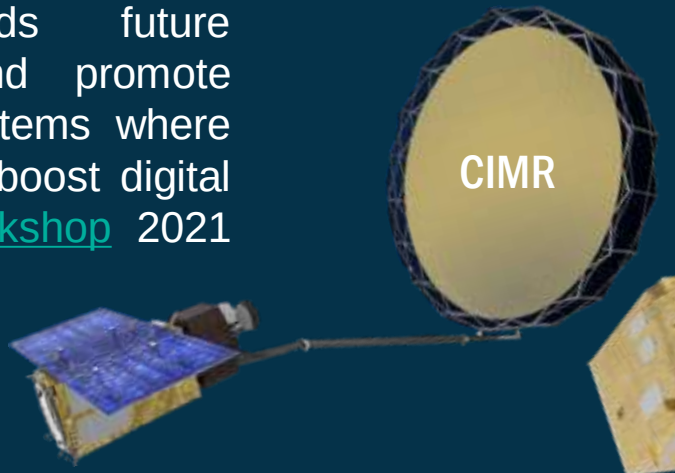
SUP is a preparatory initiative for the use of Copernicus Expansion/NG data. Strong support by MS and EARSC.
With a multi-mission approach.

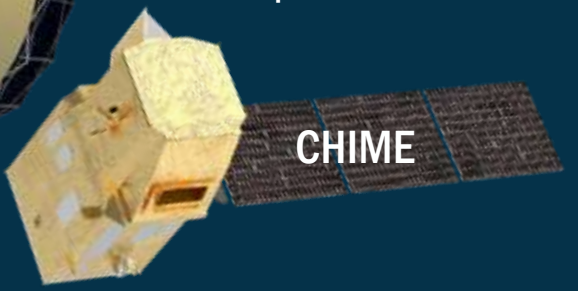
WHY

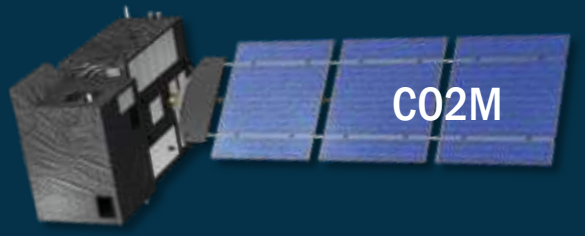
Supporting the integration of new Copernicus Expansion/NG datasets towards future operational working practices and promote European leadership for space systems where competitors are already active and boost digital commercialisation (ref. EARSC workshop 2021 with D-EOP).

HOW

- Build the necessary expertise in the various science and application domains and sectors (academia, value adding companies) to prepare future downstream services.
- Ensure readiness for rapid uptake by users and stakeholders of derived information products.







EFFECTS

- Readiness of science and downstream analytics to address societal/environmental challenges.
- Act as ‘de-risking’ factor and incentive for growth to maximise return-on-investment.

Stakeholders and Users Consultations

Continuous consultations via existing mechanisms (e.g. Living Planet Symposium, Mission Advisory Groups, Thematic workshops). Example of workshops:

- 26th International Ocean-Colour Coordinating Group Committee meeting. 27-29 June 2022. Frascati, Italy.
- Second Workshop on International Coordination for Spaceborne Synthetic Aperture Radar. 28-30 September 2022. ESA/ESRIN, Italy.
- World Ocean Circulation Final User Consultation. 10-12 October 2022. ESA/ESRIN, Italy.
- Sentinel-5P Mission 5 years anniversary meeting. 10-14 October 2022. Taormina, Sicily, Italy.
- Open Information and Consultation Day for CSOs / NGOs on Earth Observation for Ecosystem Conservation and Restoration, 14 October 2022, online.
- 2nd Workshop on International Cooperation in Spaceborne Imaging Spectroscopy. 19-21 October 2022, Frascati, Italy.
- 4th Carbon from Space Workshop - 25-28 October 2022 ESA-ESRIN, Italy.
- 2022 Workshop On Earth Observation For Ecosystem Accounting, 28 November - 01 December 2022, virtual.
- 13th Coastal Altimetry Workshop. 6-10 February 2023, Cádiz, Spain.

Stakeholders and Users Consultations

Continuous consultations via existing mechanisms (e.g. Living Planet Symposium, Mission Advisory Groups, Thematic workshops). Example of workshops:

- SeaSAR 2023, 02-06 May 2023, UNIS Svalbard, Norway.
- International Workshop on High-Resolution Thermal EO. 10-12 May 2023. Frascati, Italy.
- PolInSAR & Biomass 2023. 19-23 June 2023. Espaces Vanel Toulouse, France.
- Coastal Erosion Workshop. 4-5 July 2023. Frascati, Italy.
- 19th International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-19). 4-6 July 2023. (LSCE and CNES) Paris, France.
- Fringe 2023, 11-15 September 2023, Leeds, UK.
- EO for Carbon Markets. 3-5 October 2023, Frascati, Italy.
- Big Data from Space 2023 (BiDS). 6-9 Nov 2023. (ESA and DG JRC). Vienna, Austra.
- Hydrospace 2023. 27 Nov - 1 Dec 2023. Lisbon, Portugal.
- Symposium on EO for Soil Protection and Restoration, 6-7 March, 2024, Frascati
- ……..

Enabling actions

➔ **Multi-mission** approach.

➔ **Enabling actions** on:

1) **[SUP-1] Applications preparedness with stakeholder and end-users**
2) **[SUP-2] SUP Sharing and Collaboration Environment**
3) **[SUP-3] Fundamental research and algorithm/products developments/validation**
4) **[SUP-4/5] New processing methods for Sentinel Expansion class datasets**
5) **[SUP-6] Training, toolboxes and education**

➔ **Representative dataset consolidation** (e.g., in terms of revisit time, resolution, and spectrally/technique) over specific areas of interest, with stakeholder engagement as necessary, through: proxy-data from non-ESA missions (national, international partners, commercial), simulated/ synthetic data from models, and in-situ/validation/campaign data. Leveraging and complementing existing infrastructure/datasets and planned campaign data.

SENTINEL USERS PREPARATION

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SUP Procurement approach

➔ **Separate ITTs** for the various Enabling Actions:

- [SUP-1] Applications Preparedness ITT (15ME)
- [SUP-2] Sharing and Collaboration Environment in synergy with Reproducible Open Science [DI-4] and the Application Propagation Environments [DI-3]
- [SUP-3] Fundamental research and algorithm, products development, and validation (4ME)
- [SUP-4/5] Novel Processing Methods for Sentinel Expansion class datasets (1.5ME)
- [SUP-6] Training/Toolboxes in synergy with other FEO B4 activities

➔ Major opportunities for industry and academia

[SUP-1] - Applications preparedness with stakeholder and end-users participation Fixed Call for Proposals – 15ME overall – 800kE each contract – 2year implementation.

- Develop and validate **novel advanced** EO application/information-product, demonstrating the value of the **Copernicus Expansion multi-mission approach** (i.e., selecting at least two missions) and the synergy with the existing Copernicus Sentinel missions. Interoperability and reusability shall be ensured.
- The contractor shall ensure the **proactive involvement of stakeholders/end-users** in the co-design, development and validation phases, and highlight expected future benefits of the developed solution.
- Consolidate and deliver the **Representative Dataset** (e.g., revisit time, spatial resolution, spectral characteristics) of the selected Copernicus Expansion missions, in order to simulate an operational scenario suitable to the selected application over the areas of interest. This Representative Dataset can be achieved through: proxy-data from non-ESA missions (e.g., national, international partners, commercial), and/or simulated/synthetic data with the aid of models, and/or in-situ/validation/campaign data.

[SUP-1] - Applications preparedness with stakeholder and end-users participation
Fixed Call for Proposals – 15ME overall – 800kE each contract – 2year implementation.

Multi-missions Applications topics:

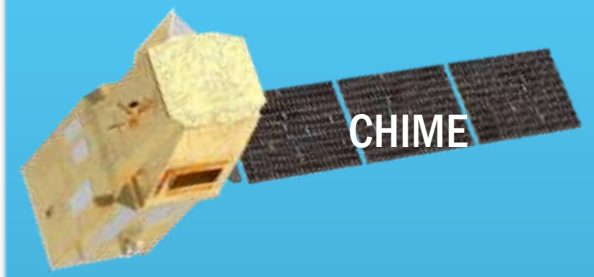
- food systems and agriculture
- ecosystem and biodiversity monitoring
- soil management
- inland water management
- coastal management
- GHG and air quality
- forest management
- urban resilience
- critical infrastructure management
- mining and extractives
- Arctic operations
- natural hazard

Examples	CHIME	CMIR	CO2M	CRISTAL	LSTM	ROSE-L
Food systems and agriculture (e.g., crop indices, operations monitoring, yield estimation, water productivity with soil moisture, irrigation, evapotranspiration, eco-schemes)	x		x		x	x
Ecosystem and biodiversity monitoring (e.g., ecosystem structural and functional traits, habitat mapping, protected areas conditions monitoring)	x		x		x	x
Soil management (e.g., composition, organic carbon, degradation, restoration)	x	x			x	x
Inland water management (e.g., hydrology services and pollution)	x			x	x	
Coastal management (e.g., eutrophication, SST, currents)	x				x	x
GHG and air quality (e.g., XCO2, XCH4, NO2, SO2, ozone, aerosols, VOC)	x		x			
Forest management (e.g., classification, biomass/carbon, health, disturbances)	x				x	x
Urban resilience and insights (e.g., UHI)	x		x		x	
Critical infrastructures management (e.g., energy infrastructure, road and rail networks, ports)	x		x		x	
Mining and extractives (e.g., site selection ,operations support, waste management, environmental protection, site remediation)	x		x		x	x
Arctic operations (e.g., safe navigation, arctic policies)		x		x		x
Natural hazard management (e.g., geological hazards, multi-hazards, green transition risk exposure, post-event monitoring).	x	x			x	x

Examples of multi-mission for agriculture

Example of consolidated initial inputs

- International coordination: SAOCOM and JAXA ALOS Palsar
- User consultations: LPS22, Fringe, SeaSAR, PolInSAR



- International coordination: ASI, DLR, NASA, JAXA.
- User consultations: EARSeL, WHISPERS, 2nd Int. Workshop
- Ongoing projects.

- International coordination: NASA, CNES, ASI.
- European Ecostress (NASA) Hub
- ET4FAO

Preparedness of stakeholder and end-user community for **new pre-operational Agriculture Applications** in response to Regulations and stakeholders' needs

- Further insight of phenology, active production, crop yield, water productivity and other advanced vegetation stress indices (e.g. chlorophyll / nitrogen / leaf area and fractional cover composition / canopy water content) for functioning and health monitoring (e.g., diseases, nutrients management, food security, agri-insurance)
- New land classifications, especially for: oil-crops monitoring, rice mapping and yield estimation, canopy disturbances, agri-biodiversity, ecosystem accounting, habitats monitoring
- Better estimation of agri-carbon eco-schemes
- Top soil (both mineral and organic matter) properties (e.g., land degradation mapping, regenerative agriculture schemes)
- Better in-land water and ground-water dynamics monitoring
- Pollution (e.g., agri-induced) captured in the fields and/or in discharge waters (e.g., rivers, lake, coastal)
- Gross Primary Productivity
- Dedicated land surface temperature, soil moisture and evapotranspiration applications such as: water productivity, irrigation uniformity and adequacy, water consumption efficiency, seasonal water consumption

[SUP-1] - Applications preparedness with stakeholder and end-users participation
Fixed Call for Proposals – 15ME overall – 800kE each contract – 2year implementation.

Invitation to Tender: "APPLICATIONS PREPAREDNESS WITH STAKEHOLDER AND END-USERS PARTICIPATION – FIXED CALL FOR PROPOSAL"

Invitations to Tender, Users January 8, 2024

The Sentinel Users Preparation (SUP) is an initiative within the FutureEO programme of the ESA Earth Observation Programmes (EOP) Directorate. Overall, the SUP initiative will invest in a dedicated set of connected developments to ensure that European entities are optimally placed to exploit the opportunities due to the future Copernicus Sentinel Expansion and Next Generation missions. All activities respond to the needs and recommendations identified through events carried out with the relevant stakeholder communities.

This procurement, titled *Applications Preparedness with stakeholder and end-users participation* is the first of a series of actions to strengthen expertise in diverse application domains to prepare future downstream services addressing high-priority societal challenges, and to enable rapid uptake by end-users and stakeholders of the derived information products. The objective is to develop and test methodologies to exploit Copernicus Sentinel Expansion class datasets in existing application domains in order to consolidate the added value of the

[SUP-1] – Applications preparedness with stakeholder and end-users. Possible Further Activities in 2024

1) Continue stakeholder consultation processes with an interest in the Sentinel Expansion and Next Generation Missions and further consolidate new recommendations;

-> Throughout 2024 e.g.:

- ESA EO4Health User Forum 2024, 15-16 January 2024, ESRIN
- Symposium on EO for Soil Protection and Restoration, 6-7 March, 2024, ESRIN
- EO for Agriculture Under Pressure 2024 Workshop, 13-17 May, 2024, ESRIN
- …..
- 3rd Workshop on International Cooperation in Spaceborne Imaging Spectroscopy, 13-15 November 2024, ESTEC.
- ….Living Planet Symposium 2025

2) Develop representative dataset (i.e., in terms of revisit time, resolution, spectrally) with a **global approach**.

3) Specific products in response to high-priority matters identified by the stakeholder consultation processes;

4) Support the development of completely new geophysical and information products.

[SUP-2] - SUP Sharing & Collaboration Environment
Application Propagation Environment (APEx)

- Upcoming EOP-S activity for Q1 2024, 7.5MEUR over 5 years, currently in negotiation phase.
- **APEx will enable better reuse & adoption of EO R&D results by providing a range of (cloud-based) instantiation and propagation services**. Rather than "*yet another platform*", APEx will integrate, streamline and enhance existing European EO platforms services & provide interoperability requirements for contributing platforms.
- **Instantiation services**:
  - Rational: prevent reinventing the wheel, provide highly configurable working environments to R&D projects.
  - Functional scope: project portals, Interactive Development Environments, datacubes and dashboards as a service, federated data access, geospatial storytelling, executable tutorials, web-based visualisation environments, managed object storage and user workspaces.
- **Propagation services**:
  - Rational: streamline the hosting of R&D algorithms, foster reuse, increase algo computational efficiency
  - Functional scope: Algorithm Hosting, Upscaling service, Algorithm Enhancement service, Cloudification Service, Algorithm Intercomparison Service
- More info: https://eo4society.esa.int/2023/10/04/invitation-to-tender-application-propagation-environment-apex/

[SUP-3] - Fundamental research and algorithm, products, development and validation

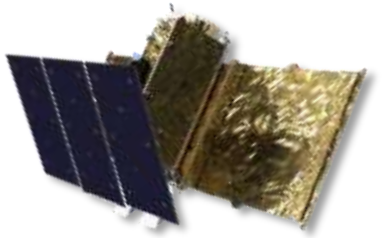
- **ITT (~500KEuro) - S5 and synergistic S5/CO2M CO2** retrieval community algorithm: Build a prototype CO2 retrieval algorithm for the Sentinel-5 mission and synergistic retrievals with CO2M in an open-source framework and develop plan for scientific use (further development). Perform algorithm performance assessment and generation of synthetic data for testing.
- **ITT (~2x500KEuro) - SWOT Data analysis and synergistic study for S3NG preparation**: Assessment SWOT capabilities (imaging interferometer dedicated) in preparation for S3-NG and exploration of synergies with SAR nadir altimeters. Data will be available at Launch + 9 months. This study will access and process SWOT mission data to investigate the scientific content of the measurements available and develop innovative approaches to exploit the measurements for ocean, inland waters, cryosphere (sea ice) and other new scientific domains.
- **ITT (~500KEuro) CHIME/S2NG for water quality and coastal biology**. In collaboration with TREC (Traversing European Coastlines) campaign to ensure wide coverage of in-situ biological information, HR Hyperspecial analysis for coastal ocean color and biology including ocean carbon parameters, 4-dimensional ocean phytoplankton abundance and composition. The results will also contribute to the verification of the proposed additional water bands in Sentinel-2 Next Generation.
- **ITT (~500KEuro) Multi-mission (S1, ROSE-L, CMIR, CRISTAL) sea ice integrated study** to explore opportunities for the development of advanced synergistic products and investigate the interplay between sea ice extend, sea ice deformation and sea ice thickness (snow on sea ice) including the potential to develop a community model based on an open source modular approach to enhance ocean, sea-ice and snow multi-mission simulations.

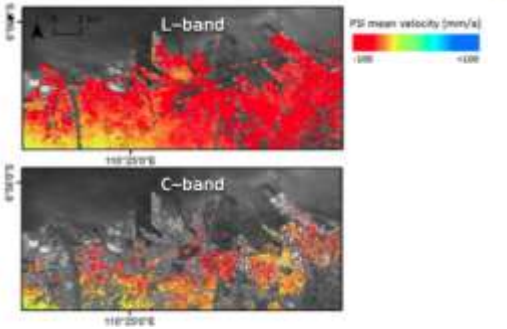
[SUP-3] - Call for early development of novel synergistic products

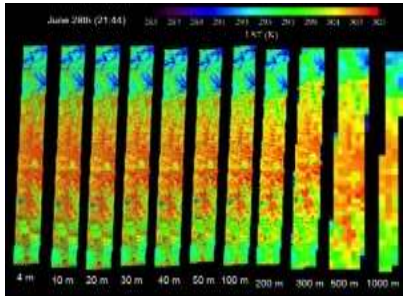
Open ITT (~2 MEuro) for up to 5 parallel studies to support early development of algorithms products with focus on synergic aspects and additional priorities beyond core mission objectives. E.g.,…..

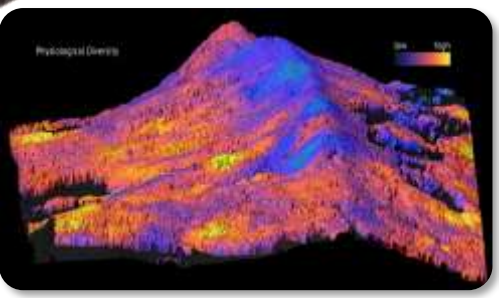
- **Glacier Ice velocity multi-frequency study** with focus on the synergy S1/ROSE-L/HARMONY (from POLAR science week) exploring potential for L-band to bridge incoherent measurements at C-band for fastest glacier (where C-band decorrelate strongly).
- **Multifrequency SAR snow products** including dry/wet extend, liquid water content at different depths, snow density, snow depth and related products: including SWE
- **Multi-frequency SAR study of novel soil moisture** C-L band products and study of potential for identifying water content at different depths (C-band for surface and L and P-band (Biomass) for sub-surfaces)
- **HR Multi-mission (CHIME/LSTM/S2NG)** advanced vegetation products/dynamics including exploring synergies between hyperspectral and thermal HR land information including vegetation health, stress, productivity, structure, water cntent…(e.g., OSE Experiments in modular carbon/vegetation models)
- **Synergistic SAR and HR Optical Forest observations** with focus on synergies of both SAR and optical data for enhance joint characterisation of structure and functioning. Assessment of potential for advanced models to jointly incorporate both types of data.
- **HR Multi-mission (S2/S3/CHIME/LSTM)** advanced soil carbon and soil/crop nutrients experiment

[SUP-4/5] - New processing methods for Sentinel Expansion data









Scope:

- Build industrial capability in a range of innovative methods for processing/enhancing Sentinel Expansion datasets (IR, HS, L-band SAR, etc) and their integration with existing datasets
- Examples include AI based methods (e.g. super-resolution, neuromorphic processing, spatial/spectral structure extraction), multi-frequency SAR methods (e.g. InSAR, PolSAR, ISAR, m-Doppler) and enhanced multi-sensor/multi-resolution fusion methods
- Specified activity includes both algorithm industrialization and testing/verification in concrete use cases/application scenarios

Implementation Approach

- Open Competitive Tender specifying diverse development lines, at least one development activity per line

Planned funding

- ~350kEuro per contract; **ITT in Q1 2024**

[SUP-6] - Training/Toolboxes and open science support

Set of activities to support the community to prepare for the coming missions including dedicated tools, training an education actions with major focus on young generations.

- SNAP+ Expansion to address Hyperspectral, Passive Microwave, dedicated multi-frequency SAR processing aspects.
- Set of SUP dedicated training events and activities focus on universities preparing young scientist and students: e.g., fostering familiarity of students with complex multi-frequency SAR data; dedicated training on hyperspectral, preparing for CO2M,…;
- Dedicated expansion of the Living Planet Fellowship to include asset of post-docs ion SUP dedicated projects.
- Expansion on Virtual Labs: expanding capabilities to cope with novel “proxi” mission including PRISMA, EnMAP, ECOSTRESS,…

SENTINEL USERS PREPARATION

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s1 ng

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s3 ngo

Thank you for your attention!

Anke.Schickling@esa.int

3rd Workshop on International Cooperation in Spaceborne Imaging Spectroscopy 13-15 November 2024 in ESA-ESTEC (Noordwijk, NL)

- Building on the experience from the successful 1st (2019) and 2nd edition (2022)
- Strengthen international cooperation and coordination in the space and ground segment operation, calibration and validation, products definition, data access and data exploitation

- Involvement of ESA, ASI, DLR, NASA with additional contribution from Japan and China
- Complementary to other relevant community driven events (e.g. 13th EARSeL WS on Imaging Spectroscopy; Whispers)