

# EO Science for Society Foresight

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Φ-lab Explore Office

Climate Action, Sustainability and Science Department

28 Mar 2024

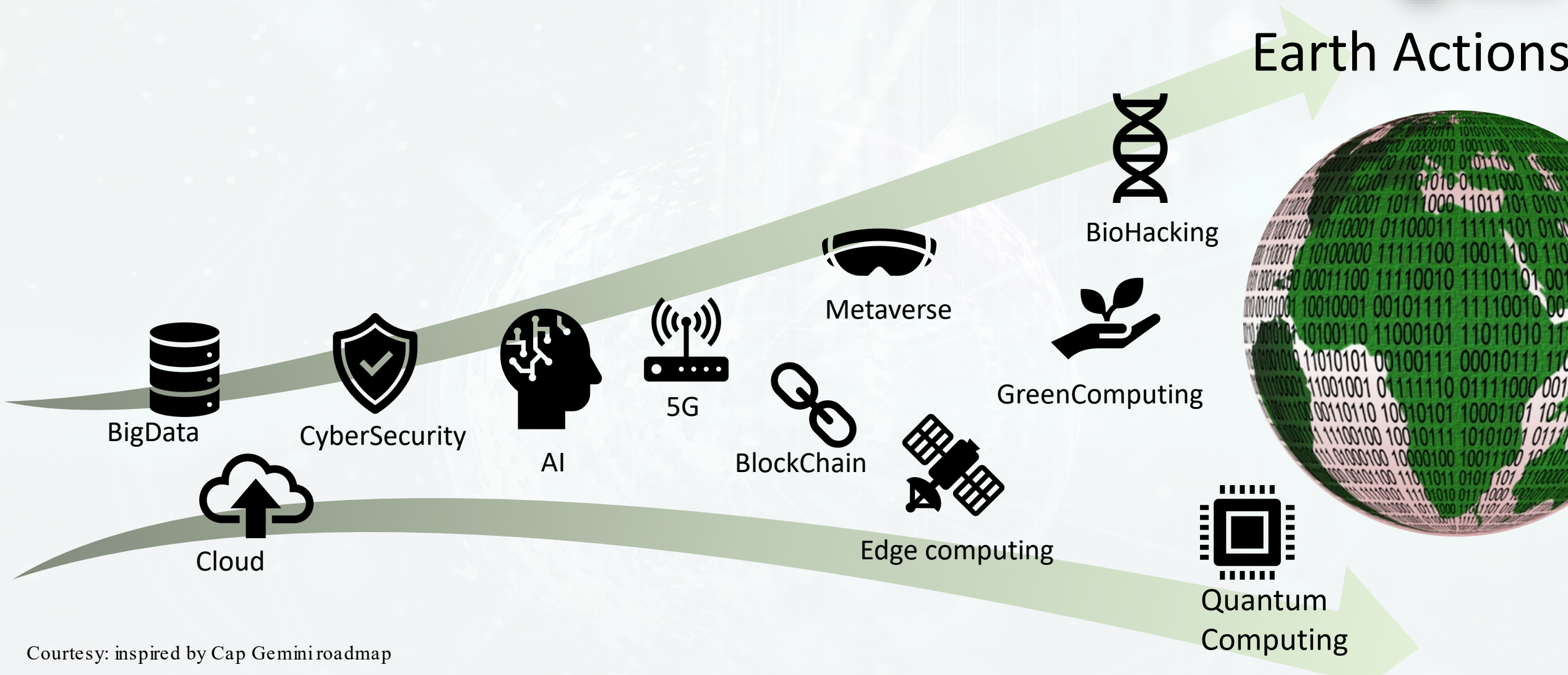
**Accelerate** the future of Earth Observation  
via **transformative/disruptive innovation**\*  
strengthening Europe's world-leading  
**competitiveness**

Uniquely in ESA  
 $\Phi$ -lab **innovate and  
apply**  
under-one-roof

\***transformative/disruptive innovation**: with the ability to completely transform or create entire industries via new methodologies or technologies



# From Foresight to Insight



Courtesy: inspired by Cap Gemini roadmap



## New Computing Paradigms

- *Edge Computing*
- *Neuro Computing*
- *Quantum Computing*
- *Hybrid HPC Computing*

## Augmented Intelligence (AI) Trust & Uncertainty

- *Explainability (xAI)*
- *Physics-Informed ML*
- *Self-supervised ML*
- *Generative ML*
- *Foundation Models*
- *Crowdsourcing*

## Connected Environment

- *Blockchain*
- *Web3.0*
- *IoT*
- *Metaverse AR/VR*

## Enabling Capacity & Community

- *Toolboxes, Data Augmentation, AI-ready data sets,*
- *Challenges, Sprints, Outreach, Hub researchers*

The world of EO is dramatically changing driven by the digital revolution. Such unprecedented “speed of change” calls for extremely “rapid innovation” enabling the new generation of scientists or entrepreneurs to rapidly test and prototype emerging disruptive technologies (such as, but not only, AI, blockchain, IoT, evolution of internet / web3, immersive visualization, etc..), new paradigms of **hybrid computing** (Edge computing but also more forward-looking Quantum computing) and explore their convergence with EO.

This activity aims to bring **the agile mechanisms to perform “rapid experiments”**, exploring this “new frontier” of convergence of disruptive technologies and EO, and test their strengths but also weaknesses. A variety of highly innovative **agile “sprints” will be performed to explore the new generation of technologies also with deep tech startups, aiming to bring new players from outside our traditional space ecosystem.** The idea of “sprints” is to rapidly prototype innovative EO solutions in a cycle of improvements that supports learning and adjusting direction as issues and opportunities arise.

Status: Q3 2024

Duration: 24 months, each sprints <6months

Budget: 3 thematics x 500k€ (with multiple sprints)

## analytics

This call is part of the family of activities on “Explainable AI” driven by the need to enhance the adoption of AI by increasing trust in the “black box”. Big issue raised in many workshops with AI practitioners (e.g.  $\Phi$ -week). Explainable Artificial Intelligence (xAI) is a rapidly evolving field that seeks to **make AI systems more transparent and interpretable**, which is essential for trust in the analysis and decision making.

This specific activity will aim to whiten the black box of AI that now pervades all fields of EO analytics by targeting 4 topics of interest: (1) **model interpretability** with uncertainty, inner-mechanism explanations, etc... (2) **explainability of causes** with causal machine learning for spatio-temporal data, (3) **interpretability of outcomes** with infovis and semantic interpretability, and (4) **user-centric explainability**, with human-in-the-loop to construct xAI models with a **coding co-pilot**.

Status: Q4 2024

Duration: 12 months

Budget: 4x250 k€



The advent of new computing paradigms such as quantum computing and high-performance computing (HPC) has opened up a world of possibilities for Earth observation. Quantum computing, based on the principles of quantum mechanics, has the potential to vastly increase the speed of data processing, while HPC enables complex simulations and analysis. As these new computing paradigms become more widely adopted, they provide unprecedented opportunities to explore the Earth's environment and pursue a more data-driven approach to earth observation.

This activity will develop quantum and hybrid computing approaches for EO. It will aim to demonstrate the potential of synergies and complementarities of software and computing resources in a modular HPC environment, to better understand Earth's climate, predict natural disasters, and monitor the environment.

Status: Q2 2024

Duration: 12 months

Budget: >500k€

Generative AI is the new wave in machine learning. This activity aims to **explore the potential of state-of-the-art generative AI techniques for EO** (in particular regarding the fast generation of synthetic data, filling-in of data gaps, enhancement of resolution, simulations, agent modelling) to rapidly **detect and classify features in large amount of EO data from multiple satellites** (e.g Sentinel, next gen Sentinel, Prisma, EnMap, IRIDE, EE, etc..) and predict their evolution.

Status: Q4 2024

Duration: 12 months

Budget: 1M



This activity aims to **explore the use of decentralised AI techniques** to leverage the collective power of EO, whereby each node of the network contributes to the overall learning of a big integrated AI model. This approach is **promising to improve scalability**, reduced latency, and **enhanced privacy/security (as data can stay localised)**, or where the AI model can continue operating even if some nodes of the network fail. The initiative will look into privacy machine learning and AI safety. In addition, the perspectives to apply such techniques for large constellation systems may be investigated.

Status: Q3 2024

Duration: 15 months

Budget: <500k€

This activity is part of a family of activities aiming to bring more insight into the AI blackbox. This is crucial for ensuring that the predictions generated by these models are trustworthy, so users feel confident to use the technology, in particular given the rapidly growing size of AI models with the emergence of mega Foundation Models.

More specifically, this activity will investigate AI for Climate activities aiming to bring more AI insight to other Earth planetary action domains. To catalyze climate action into public health domain, AI models can generate technological solutions to quantify the impact of climate change on human health in multiple applications. This specific activity will address AI safety and robustness (and will capitalise on the results of previous activities on Foundation Models) and explore how the latest techniques of uncertainty quantification (e.g. using model visualization, prior knowledge and physics-informed neural network) can help better assess the “veracity” (e.g. addressing the issue of hallucinations) and “traceability” of outputs to build more confidence/trust in the AI4EO applications

Status: 2024 Q4

Duration: 12 months

Budget: 500k



This activity is **part of a family of activities on edge computing**. This specific call will explore how to enable continuous learning from different types of data (e.g. optical, radar) can be implemented at the edge starting **from “raw” data** by integrating the latest measurement to update the machine learning model.

Status: 2024 Q3

Duration: 12 months

Budget: 500k

This call is a follow up of the study on web3 looking in the evolution of the internet and blockchain. It will aim to develop a suite of use cases (proof of concepts) highlighting the added value of distributed ledger technologies for EO, e.g. ensuring traceability of data, creating digital asset and new business models.

Status: Q4 2024

Duration: 12 months

Budget: 5x150k

# FS-15 EO assistant Framework for Sensor Enhancement

This activity aims to foster the development of a generic AI-based coding framework and toolboxes for sensor fusion & enhancement (e.g. including pre-trained software, dedicated AI-ready training data sets, benchmarking tools), with automatic coding functionalities (e.g. a kind of Github co-pilot for EO), enabling users to rapidly fuse and enhance data of different natures (including EO - optical, radar, hyperspectral, IoT and model simulations).

Status: 2024 Q3

Duration: 12 months

Budget: 750k€

Thank you for your  
attention

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