Way forward with Earth Observation in the actual climate crisis

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EuroGraphics General Assembly

ESA in a Nutshell

WHO	23 Member States, 2500+ staff members and total workforce of 6000+
WHY	For the peaceful use of space, benefiting all
WHERE	HQ in Paris, seven sites across Europe & Spaceport in Kourou
BUDGET	€7.7 billion = €15 (one cinema ticket) per European a year

ESA is committed to the peaceful exploration and use of space for the benefit of people society and our planet

ESRIN: ESA's Centre for Earth Observation

esa

9
Directorates

1013
People

43
Nationalities

40.000
Visitors/year

300TB
Daily EO data distribution management

Multiple Data Centres
(Totalling 772m²)

High Performance Computing
(5 PetaFLOPS)

Φ-lab Science-Hub Φ-experience Visitors centre

Renewable Energy Production
(713MWh in 12 Months)

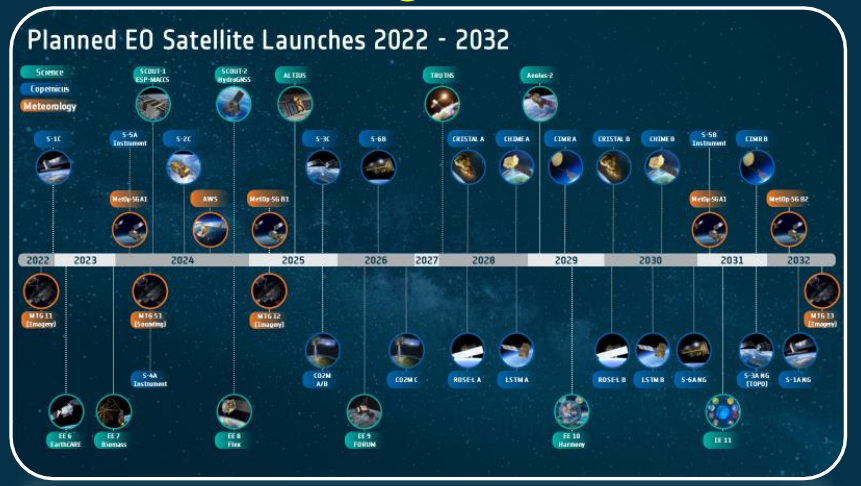
Highest ratings in Energy, Environment & Well-being
(LEED gold & Platinum and WELL platinum certified buildings)

Airbus Pleiades Neo (7 September '22)

→ THE EUROPEAN SPACE AGENCY

Earth Observation Activities at ESA

Building satellites



Managing Missions

Cal/Val & Data Distribution

Applying the Data

Innovation & Commercialisation

The Big-Data Revolution with First Generation Sentinels

Copernicus is the largest producer of EO data in the world

All global landmass is observed every 5 days at 10m resolution

30 TB of Daily Data Production by Sentinels

350 TB of Daily Sentinel Products Disseminated for Services to Society

PROGRAMME OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

co-funded with esa

CHIME

Copernicus Hyperspectral Imaging Mission for the Environment

soil properties
crop health
raw materials
biodiversity
water quality

ROSE-L

L-band Radar Observing System

geohazards
polar ice
forest management
food security
maritime surveillance

LSTM

Land Surface Temperature Monitoring

sustainable agriculture
water resources management
drought
urban heat islands

CIMR

Copernicus Imaging Microwave Radiometer

sea-ice concentration
sea-surface temperature
polar maritime security
global ocean and cryosphere
soil moisture and vegetation

CO2M

Copernicus Anthropogenic Carbon Dioxide Monitoring

carbon dioxide and methane from human activity

CRISTAL

Copernicus Polar Ice and Snow Topography Altimeter

sea-ice thickness
ice sheets and glaciers
snow
polar oceanography
coastal and inland waters

→ THE EUROPEAN SPACE AGENCY

Copernicus Space Evolution

PROGRAMME OF THE EUROPEAN UNION

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CHIME
Copernicus Hyperspectral Imaging Mission for the Environment

soil properties
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ROSE-L
L-band Radar Observing System

geohazards
polar ice
forest management
food security
maritime surveillance

LSTM
Land Surface Temperature Monitoring

sustainable agriculture
water resource management
drought
urban heat

Sentinel-1 NG

Sentinel-2 NG

sea-ice concentration
sea-surface temperature
polar maritime security
global ocean and cryosphere
soil moisture and vegetation

CIMR
Copernicus Imaging Microwave Radiometer

CO2M
Copernicus Anthropogenic Carbon Dioxide Monitoring

carbon dioxide and methane from human activity

+ Next Generation Sentinels for data continuation and enhanced observations

Sentinel-3 TOPO/OPT NG

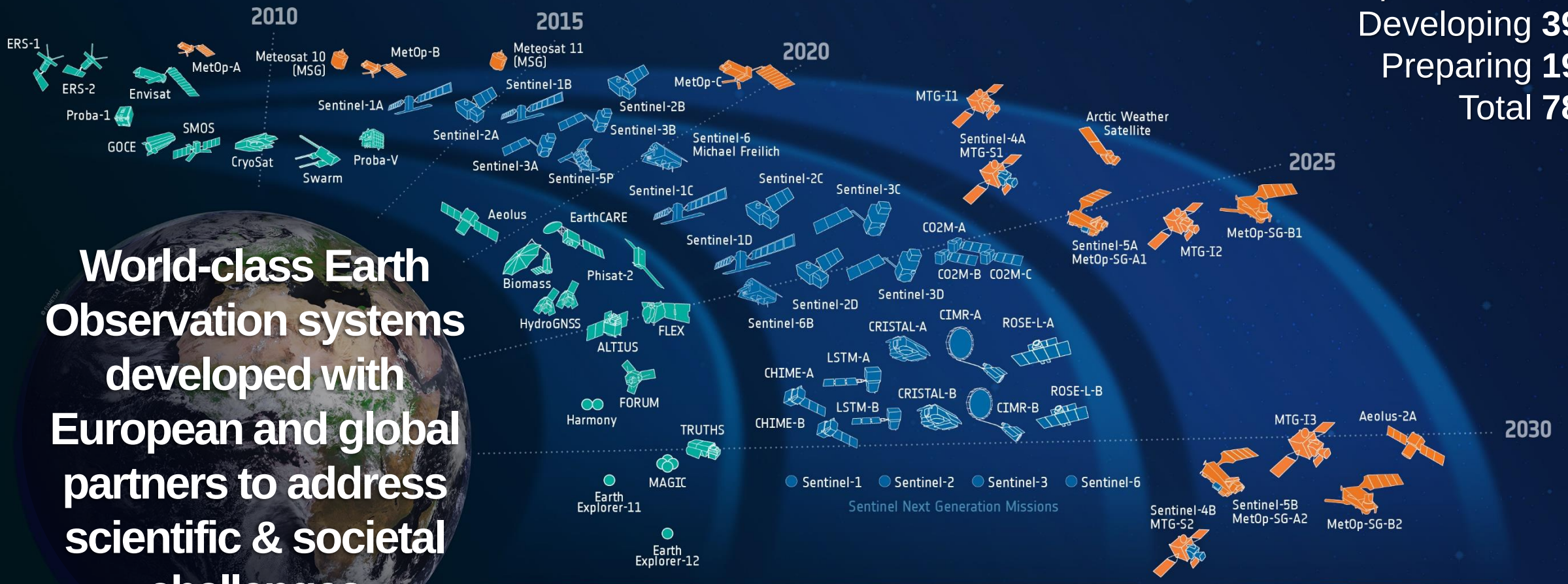
CRISTAL
Copernicus Polar Ice and Snow Topography Altimeter

coastal and inland waters
polar oceanography
snow
ice sheets and glaciers
sea-ice thickness

ESA's Earth Observation Missions

Satellites

Heritage **06**
Operational **14**
Developing **39**
Preparing **19**
Total **78**



World-class Earth Observation systems developed with European and global partners to address scientific & societal challenges

Science esa Copernicus European Union Meteorology EUMETSAT

Digital Twin Earth (DTE)

Advanced 4D data-driven Earth System reconstruction: based on novel EO capabilities, multivariate datasets (including in-situ, citizen science)

Advanced Community/Sectorial Models: Earth system components, human activities, management…

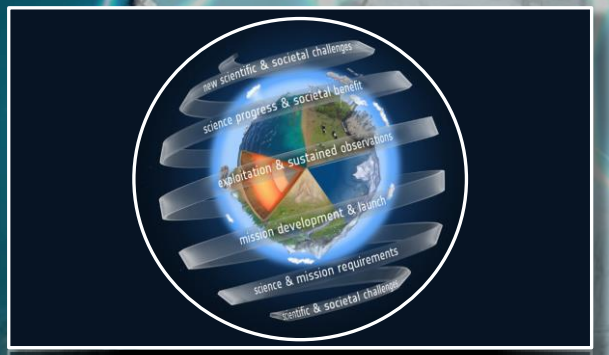
Artificial Intelligence (AI), data-driven approaches: ML, Hybrid methods, multi-variate data analytics….

ECMWF esa EUMETSAT

The FutureEO Programme

FUTURE EO

ESA's cornerstone Earth Observation R&D programme



Foundations and Concepts

Research Missions

Mission Management

Earth Science for Society

Earth Observation Science for Society

Science strategy 2024
Science Themes & Strategic Areas of Action

ST-I	ST-II	ST-III	ST-IV	ST-V	ST-VI
The water cycle	The carbon cycle and chemistry	Energy fluxes	Ecosystem health	Extremes and hazards	Interfaces & coupling in the Earth system

Table 1 Overarching science themes that guide scientific priorities within EO Programmes. A detailed description of each theme can be found in Appendix 1.

A-1: Frontier science and discovery:
a strong foundation

A-2: From science to societal benefits:
meeting society's needs

A-3: Reducing critical knowledge gaps:
taking expedient action

A-4: Filling critical observation gaps:
preparing for tomorrow starts today

Guiding Science Questions and their relevance to International Treaties, Agreements & Conventions

EO Supports Major International and European Policy Frameworks

UN SDG for 2030

Paris Agreement on Climate Change

The Sendai Framework for Disaster Risk Reduction 2030

EO Supports Major International and European Policy Frameworks

From Science to Innovation

Road map, communities recommendations, projects definition, relevant Advisory Boards

International policies

Environmental Agenda, Sustainable Development, Africa 2063

EUROPEAN GREEN DEAL

THE GLOBAL GOALS For Sustainable Development

Agend A 2063 The Africa we Want

Feedback to policy

Direct Engagement of Stakeholders and End-Users

Users' needs and pro-active engagement

integration of developed solutions

Excellence in EO innovation with Industry and Academia

- Building on Science element
- Multi-mission & inter-disciplinary

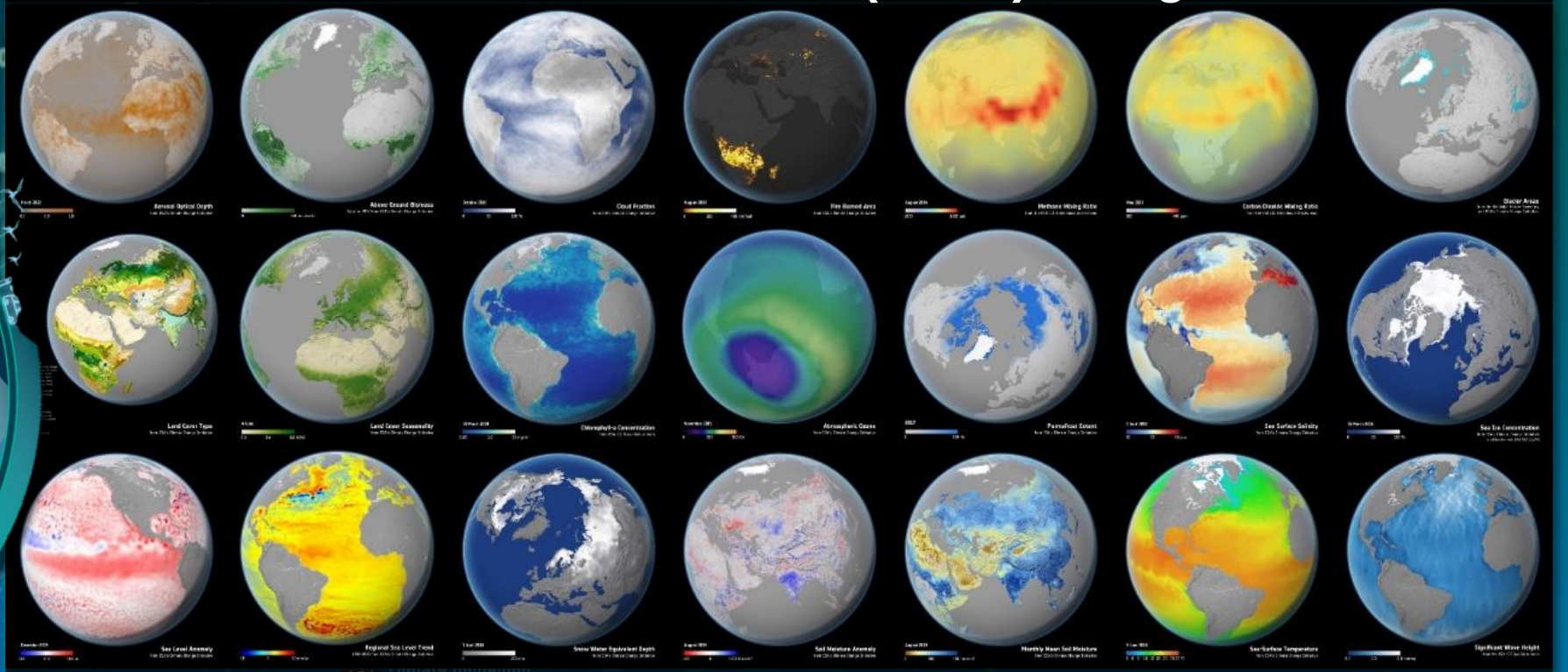
Leveraging on cutting-edge ICT for **rapid development & amplification of users**

Making more and better use of research data

CCI: Development of Essential Climate Variables Products

esa

27 Essential Climate Variables (ECVs) Being Monitored



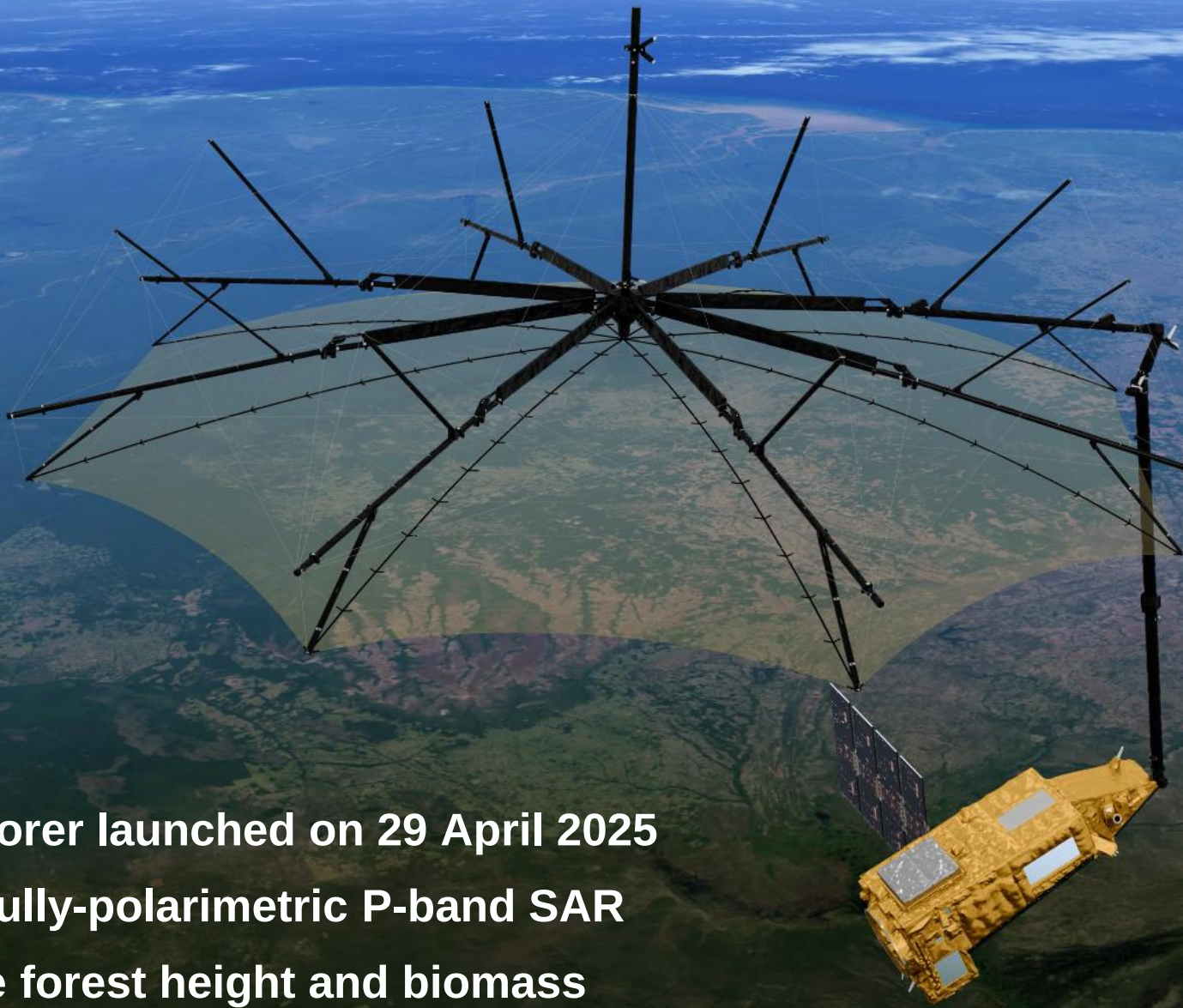
climate modelling user group cci

sea level budget closure cci

reccap-2 cci

- CCI is a response to UNFCCC's need for systematic global climate observation
- ECV datasets provide long-term empirical evidence to predict & understand key parts of the climate
- 54 defined ECVs, 36 monitored from space, 27 under development by ESA

ESA’s Earth Explorer Biomass Mission



ESA’s 7th Earth Explorer launched on 29 April 2025

An interferometric, fully-polarimetric P-band SAR

Designed to observe forest height and biomass

European Space Agency

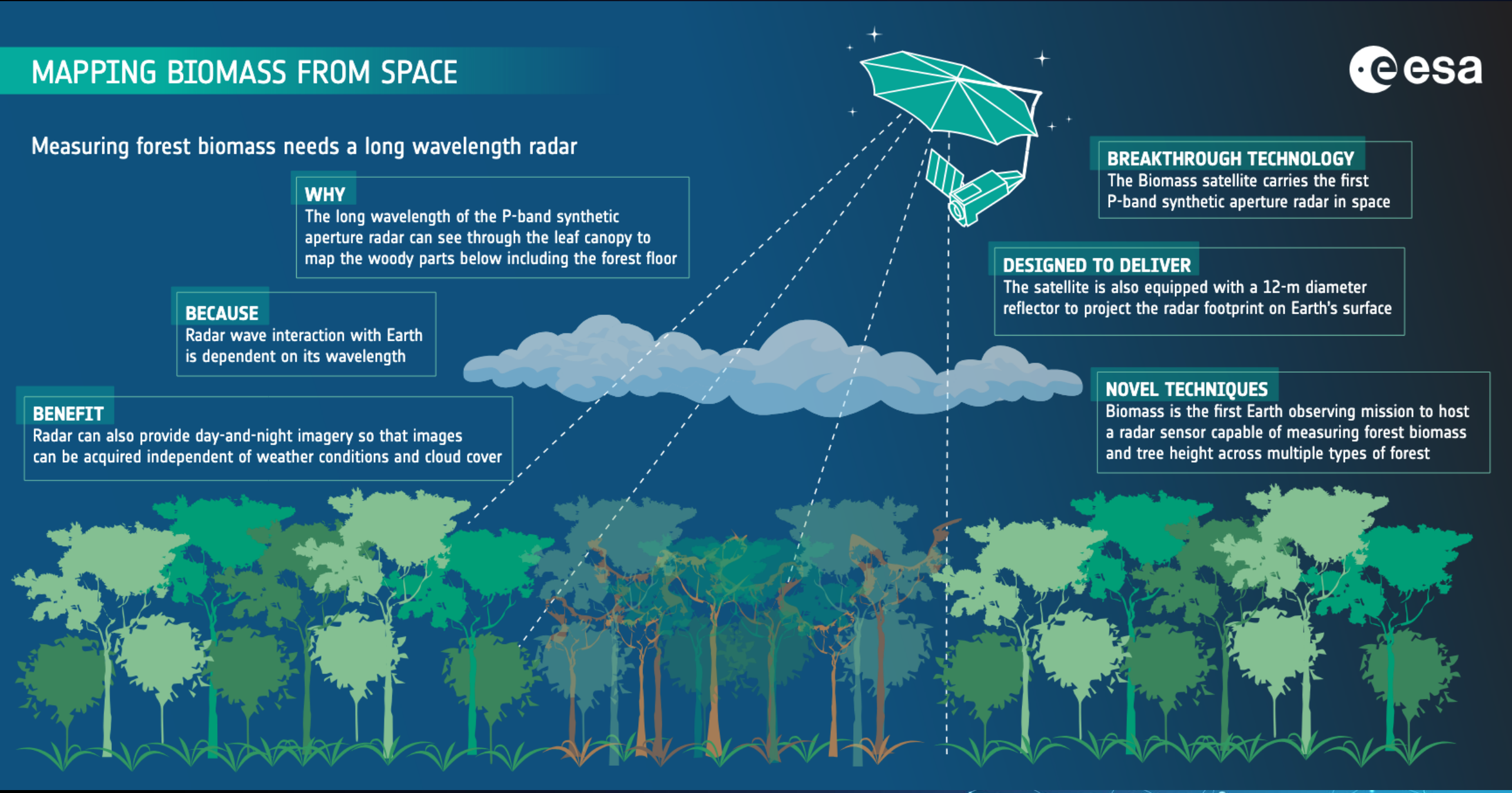
MAPPING BIOMASS FROM SPACE

Measuring forest biomass needs a long wavelength radar

WHY
The long wavelength of the P-band synthetic aperture radar can see through the leaf canopy to map the woody parts below including the forest floor

BECAUSE
Radar wave interaction with Earth is dependent on its wavelength

BENEFIT
Radar can also provide day-and-night imagery so that images can be acquired independent of weather conditions and cloud cover



BREAKTHROUGH TECHNOLOGY
The Biomass satellite carries the first P-band synthetic aperture radar in space

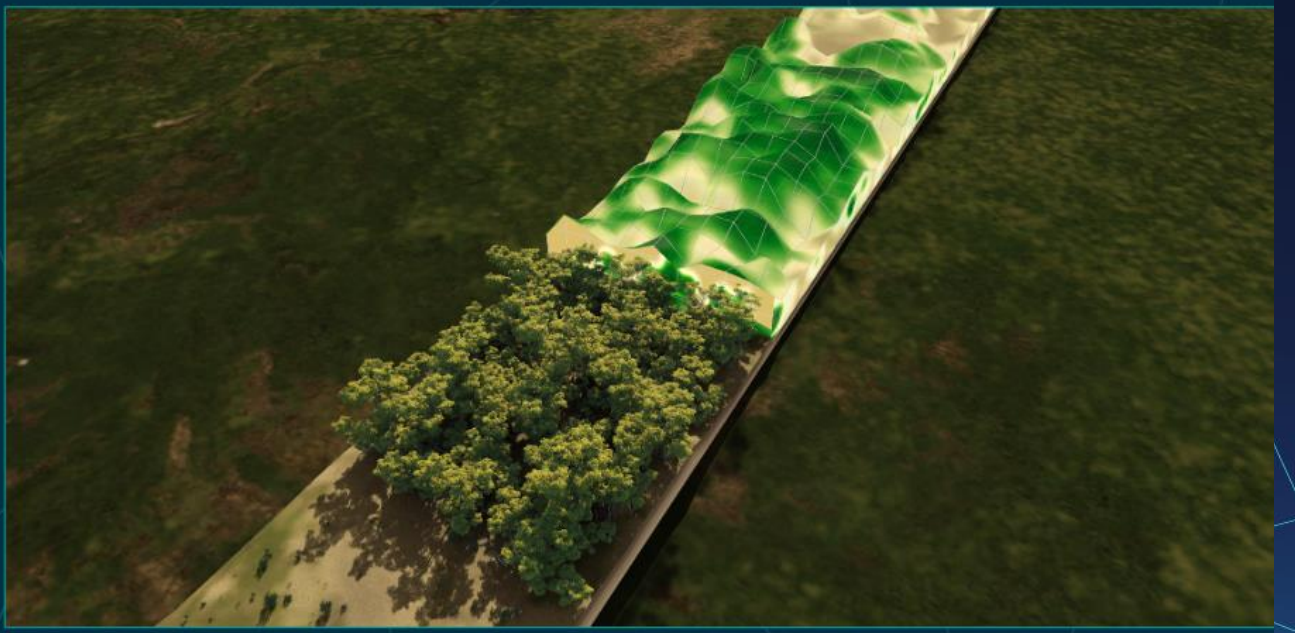
DESIGNED TO DELIVER
The satellite is also equipped with a 12-m diameter reflector to project the radar footprint on Earth's surface

NOVEL TECHNIQUES
Biomass is the first Earth observing mission to host a radar sensor capable of measuring forest biomass and tree height across multiple types of forest

Biomass on Biomass

Measuring forest mass from space is a complex challenge. However, the Biomass satellite's P-band radar can penetrate the entire forest layer, with its signal reflecting off different parts of the canopy. These data provide crucial insights into forest structure, enabling scientists to estimate biomass, height and, ultimately, carbon content.

While the concept may seem straightforward, over its 5.5 year planned life in orbit, the mission is operated in two phases to ensure it fulfils its goal: the tomographic phase at the beginning followed by the interferometric phase.



TOMOGRAPHIC PHASE

- The technique is comparable to a CT scan which combines several images to reveal information of the inner structure of a forest
- The tomographic phase takes place at the beginning of the mission and lasts around 18 months, resulting in a single global map
- It yields 3D information at 15–20 m vertical resolution and 200 m spatial resolution

Biomass is the first mission that will systematically explore this observation technique from space

INTERFEROMETRIC PHASE

- A single observation provides an initial view of the forest canopy and forest density, with multiple observations over the same area to allow forest height and above-ground biomass to be estimated
- The interferometric phase takes around four years
- During this phase around five global maps will be acquired

Change in forest biomass is the crucial variable needed for quantifying carbon fluxes and their effects on climate

ESA Earth Observation at CM25: EOP Ambitions

Upgraded FutureEO: Three pillars

EO Foundations

- system of system & gap analyses
- EO-enabling tech.
- safeguard EO capacity & autonomy
- IPD Quantum Φ-sats
- Mission early phases

EO Missions and Data

- Harmony
- Earth Explorer 11
- NGGM / MAGIC
- Scouts 5 & 6
- Mission & Data Management (flex, FORUM, +PhiSats, earthcare, biomass, HydroGNSS, smos, cryosat, swarm)

Earth Action

- Φ-lab and EO4Society
- Global Development Assistance
- Climate Space

Copernicus *(CSC-4 Phase-3)*

- TRUTHS
- InCubed-3
- Digital Twin Earth

New Integrated Policy Expert Scheme (IPES)

https://eo4society.esa.int/integrated-policy-expert-scheme-ipes/

The policy expert is seamlessly integrated into the ESA team, fostering collaboration and leveraging unique insights to accelerate the implementation of effective strategies addressing the global climate and environmental crisis.

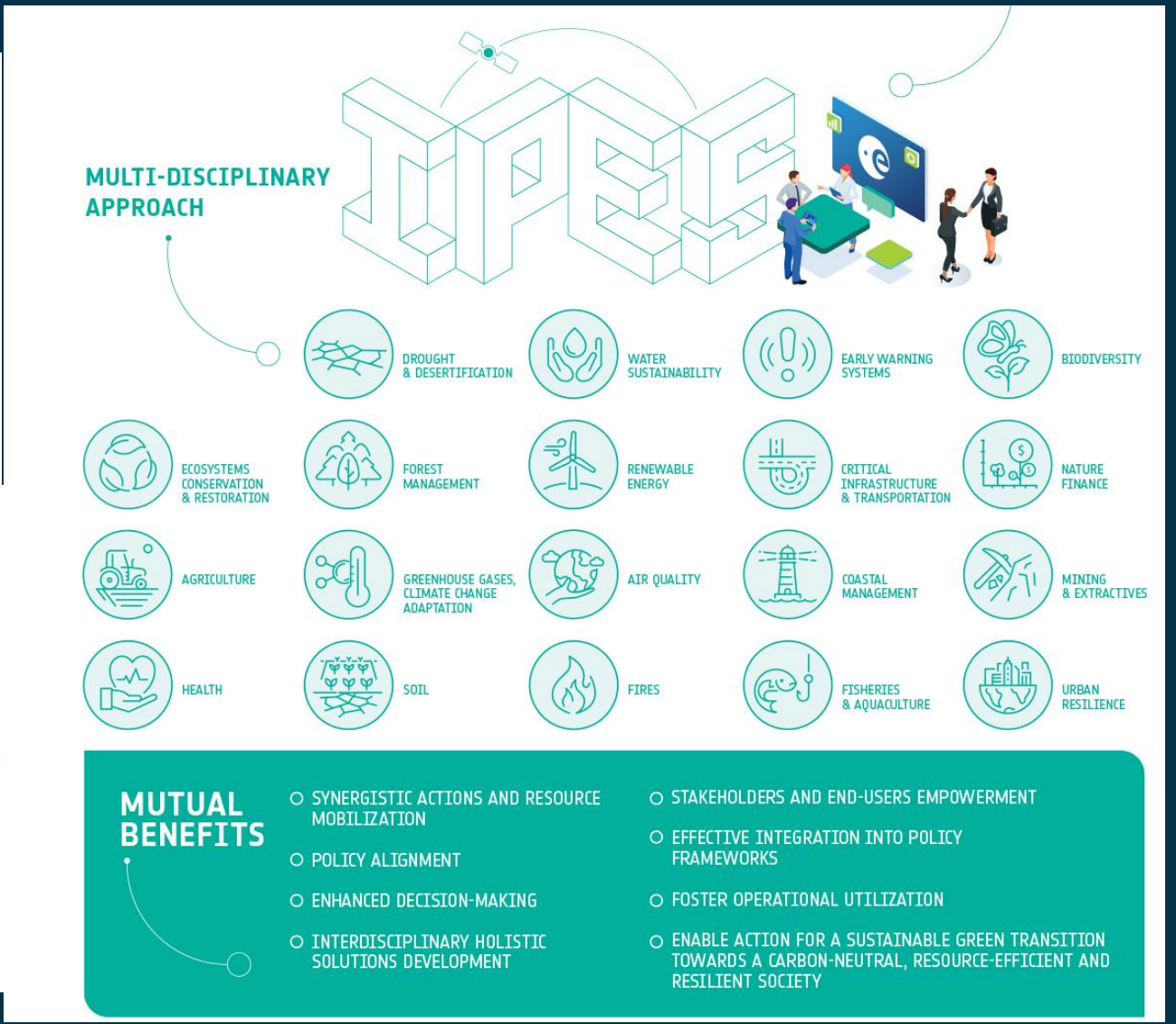
The scheme duration spans from four months to two years, with the possibility of renewal subject to mutual agreement. While actively engaged in ESA projects, the experts maintain their employment with their original organization. ESA assumes responsibility for covering related additional costs.

Launching in 2024.

Get in touch with ESA via the dedicated ipes@esa.int e-mail address.

INTEGRATED POLICY EXPERTS FROM

- INTERNATIONAL AND EUROPEAN ORGANIZATIONS
- NATIONAL / REGIONAL / LOCAL ENTITIES
- MULTILATERAL CONVENTIONS
- CIVIL SOCIETY ORGANIZATIONS
- INDIGENOUS SOCIETIES



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