# COPERNICUS
# Space sentinels: the unstinting guardians of our planet

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# Monitoring global change: scientific and societal challenges

Monitoring and understanding Earth systems

Observing Earth systems and their relationship

Understanding and modelling processes in space and time

Predicting trends and evolution

Assessing human impact


Societal needs

Forecasting the environment for the next days or weeks (precipitation, temperature, air quality, sea state, crop yield, …)

Predicting and anticipating extreme events

Addressing human needs for transportation, water supply, food, energy, communication…

# What is Copernicus?

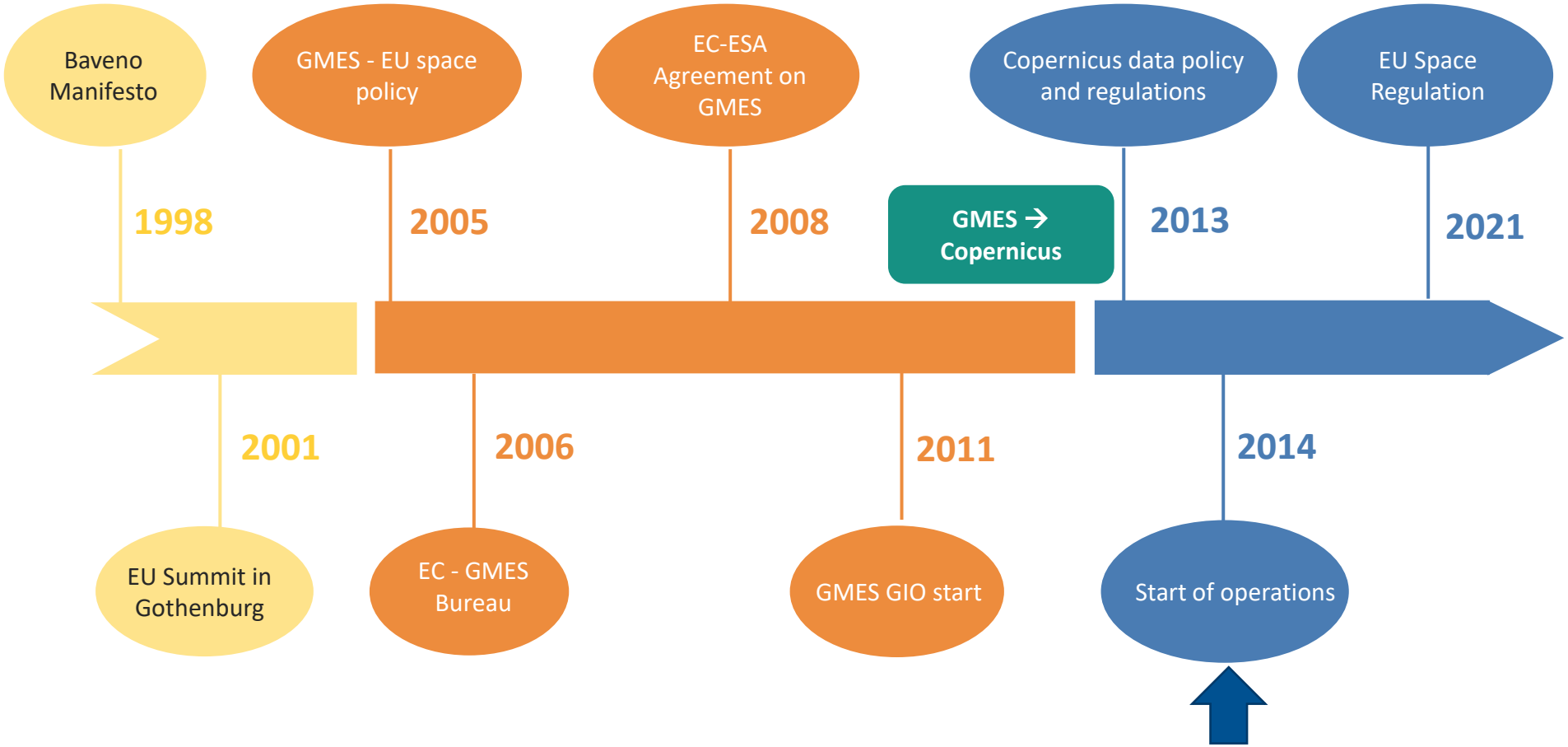
A **programme** implemented and managed by the European in partnership with Member States, ESA and EUMETSAT addressing environment and security issues, with the following objectives:

- Providing **information services** for public users **on a operational basis**
- Addressing **national and European policies** and societal challenges
- **Managing and protecting natural resources** with a sustainable perspective
- Mitigating and adapting to **climate change** impacts
- Better reacting to **natural and industrial disasters**
- **Ensuring a continuous and long term access** to data and information, under a full, free and open basis
- Opening new **commercial and economic perspectives**

## Copernicus is based on an **integrated system**

- Earth Observations from space ➔ Coordinated by ESA
- “in situ” observations ➔ Coordinated by EEA
- Operational services ➔ Coordinated by the European Commission (with delegations to entrusted entities)

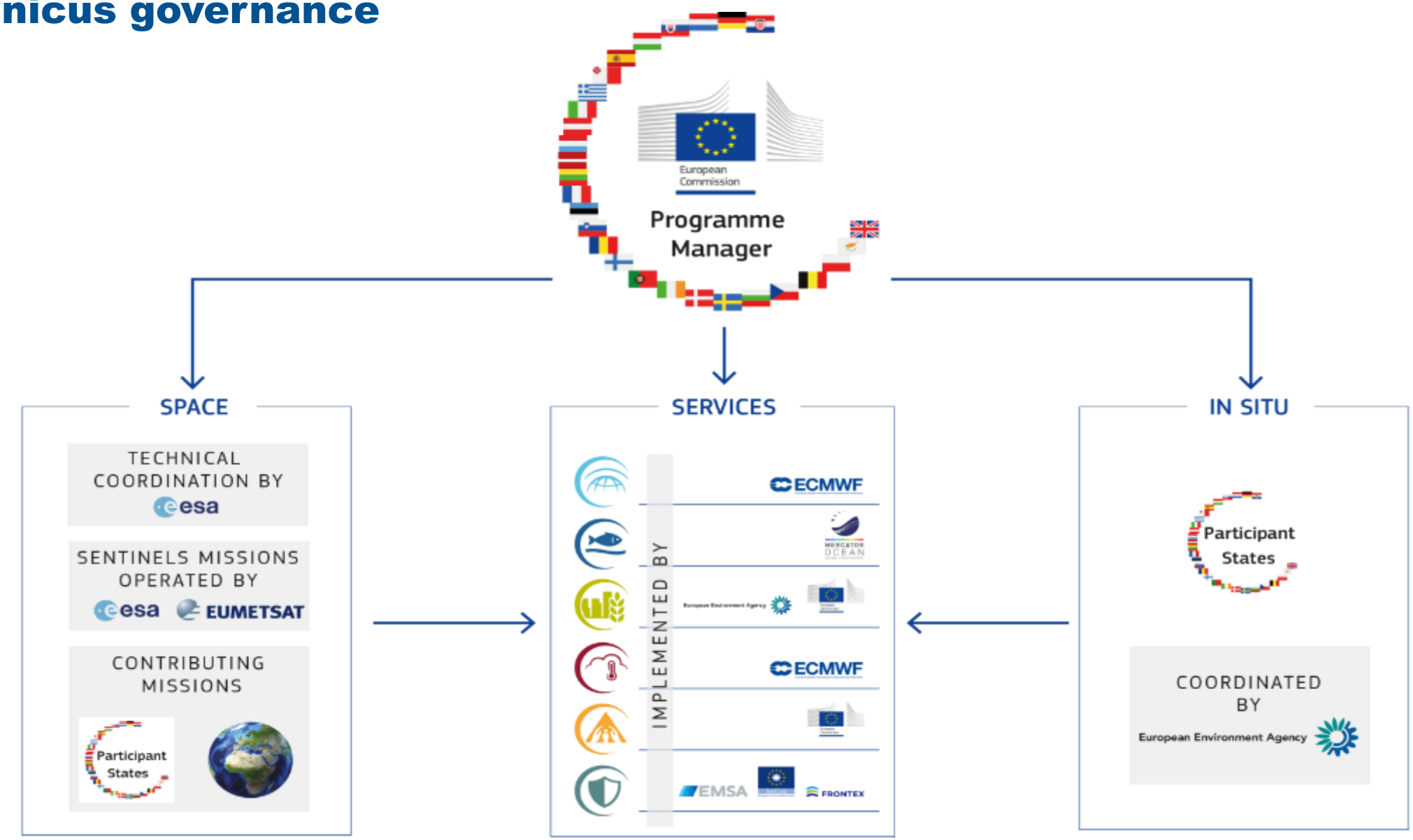
# A outstanding endeavour that started 25 years ago



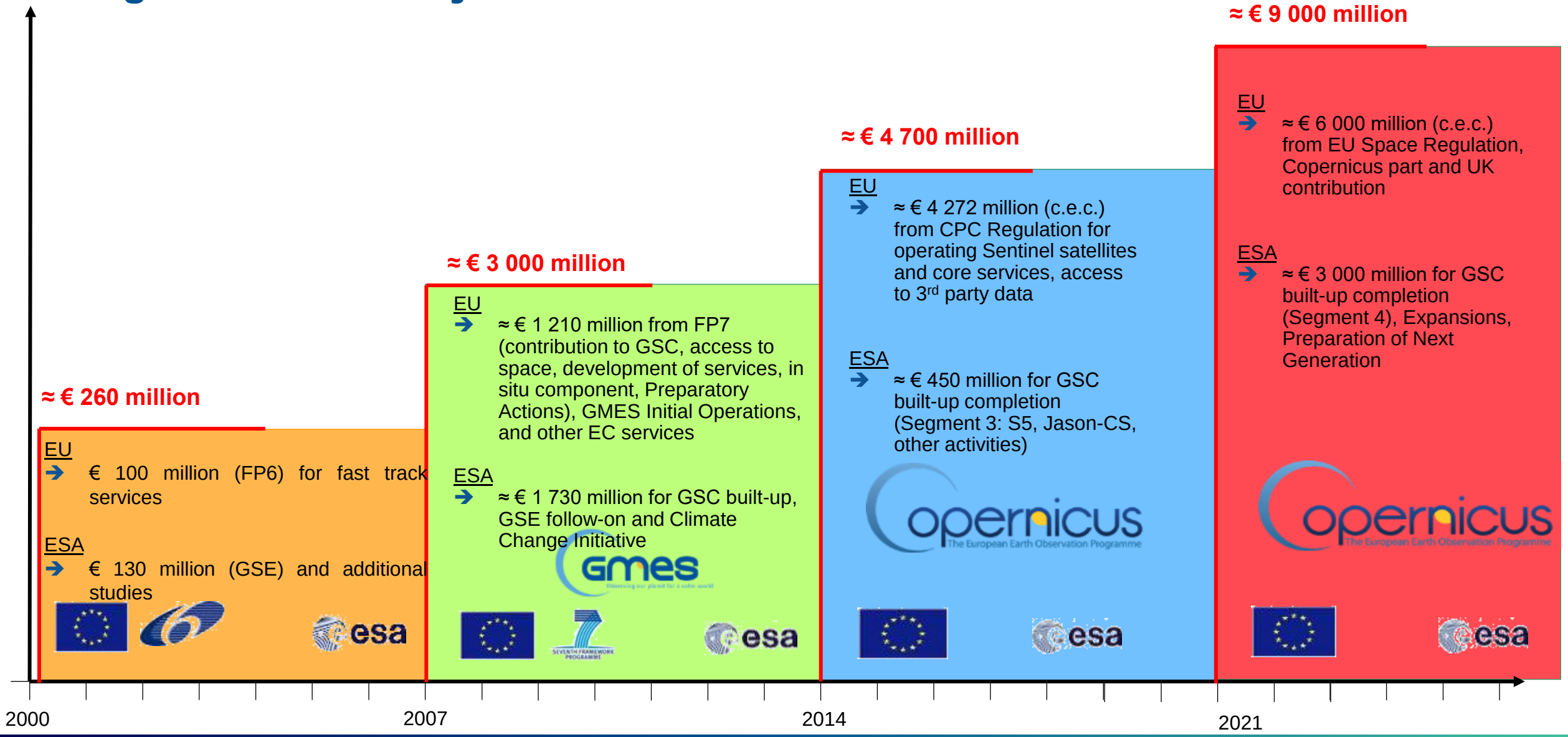

**Copernicus 25th anniversary: 8 June 2023, Stockholm**

Copernicus is operational since 2014 with 6 operational services using high quality satellite and in situ data

# Copernicus governance



# A huge effort over 25 years: 17 Bn €

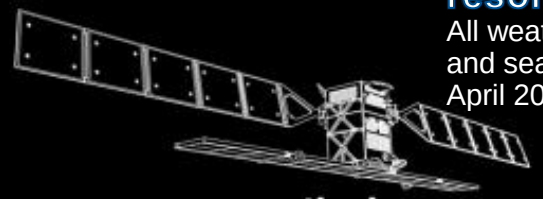


# The Sentinel constellations : the unstinting guardians of our planet

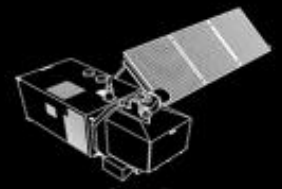
## Altimetry - 10 day revisit time
Low inclination orbit altimetry mission
for monitoring sea surface height
November 2020 / 2025


## SAR imaging - 4-40m resolution, 6 days revisit time
All weather, day/night applications, flooding
and sea ice monitoring interferometry
April 2014 / April 2016



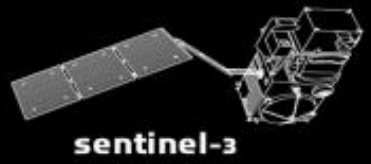

## Low-orbit atmosphere monitoring - 7.5-50km resolution, 1 day revisit time
High resolution spectrometer
covering ultraviolet, visible and
near–infrared bands
Air quality, ozone, surface UV,
climate protocol monitoring
> 2024 / 2030 / 2038


FULL, FREE AND OPEN




## Multispectral imaging - 10-60m resolution, 5 days revisit time
13 bands at 10, 20, 60m
Land applications: urban, forest,
agriculture,..
Continuity of Landsat, SPOT
June 2015 / March 2017

## Low-orbit atmosphere monitoring - 7-68km resolution, 1 day revisit time
High resolution spectrometer
covering ultraviolet, visible and
near–infrared bands
Air quality, ozone, surface UV,
climate protocol monitoring
October 2017


## Altimetry and multispectral imaging - 300-1200m resolution, <2 days revisit time
Wide-swath ocean color,
vegetation, sea/land
surface temperature, sea height
Ocean and global land monitoring
February 2016 / April 2018


## Geostationary atmosphere monitoring - 8km resolution, 60 min revisit time
High resolution spectrometer covering ultraviolet, visible and near–infrared bands
Air quality, ozone, surface UV, climate protocol monitoring over Europe
> 2024 / 2032

# Copernicus – Sentinels Status

## S-1

Radar

| | |
|---|---|
| A | 3 Apr 2014 |
| B | 25 Apr 2016 (to be de-orbited) |
| C | 2023 |
| D | > 2024 |

## S-2

High Res. Optical

| | |
|---|---|
| A | 23 Jun 2015 |
| B | 6 Mar 2017 |
| C | >2024 |
| D | > 2026 |

## S-3

Medium Res. Optical & Altimetry

| | |
|---|---|
| A | 16 FeB 2016 |
| B | 25 Apr 2018 |
| C | >2025 |
| D | > 2027 |

## S-4

Atmospheric Chemistry (GEO)

| | |
|---|---|
| A | >2024 |
| B | 2032 |

## S-5P

Atmospheric Chemistry (LEO)

| | |
|---|---|
| A | 13 Oct 2017 |

## S-5

Atmospheric Chemistry (LEO)

| | |
|---|---|
| A | > 2024 |
| B | 2030 |
| C | > 2030 |

## S-6

Altimetry

| | |
|---|---|
| A | 21 Nov 2020 |
| B | 2025 |
| C | > 2032 |

# 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

**25 TB of Daily Data Production by Sentinels**

**300 TB of Daily Sentinel Products Disseminated for Services to Society**

**> 700.000**
**Registered Users**

Supporting 6 operational services

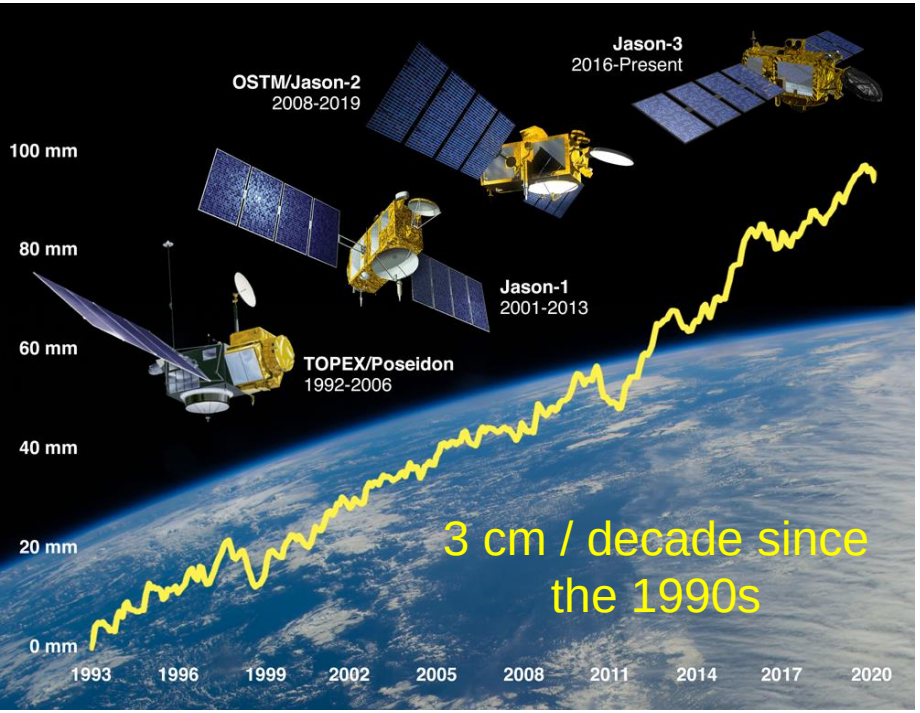
Land | Atmosphere | Ocean

Climate | Disaster | Security

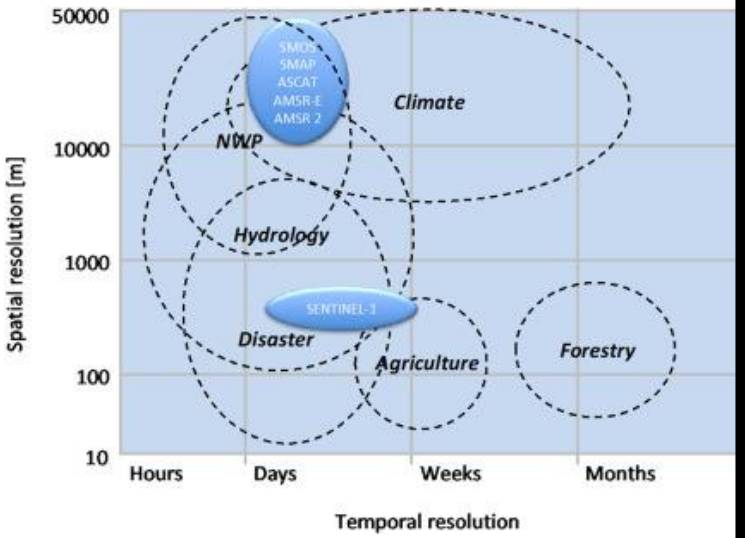
**Full, Free & Open Data Policy***

# Research priorities : improved continuity for both observations and services

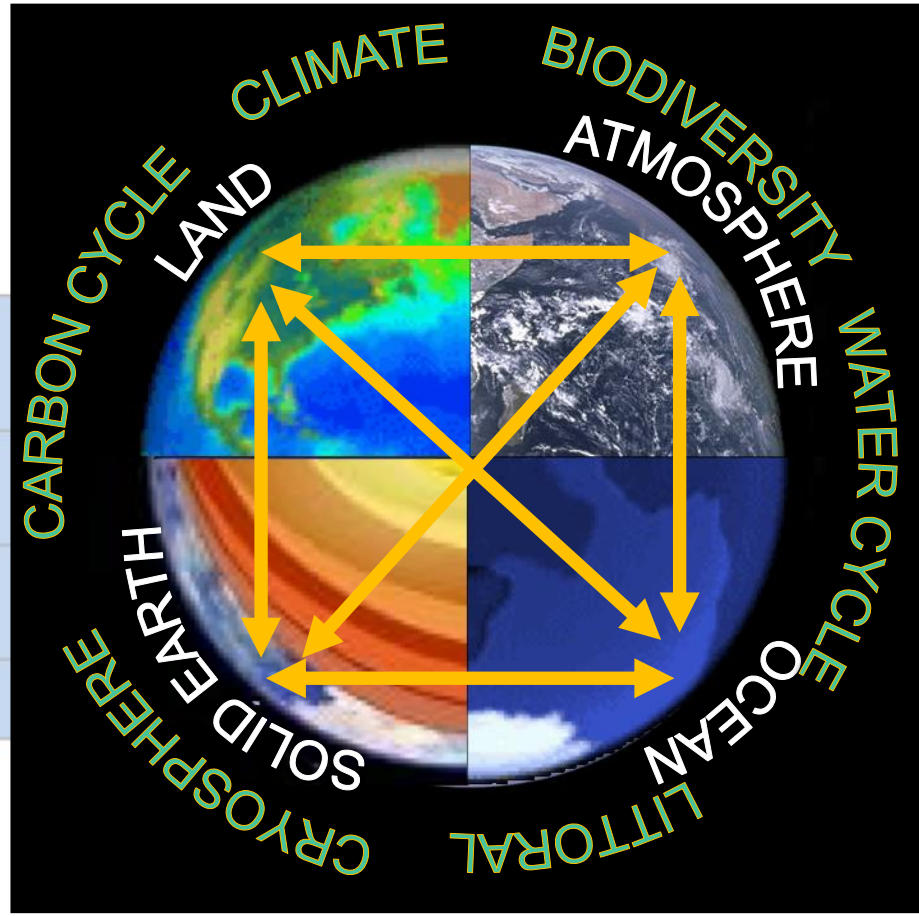
## Continuity is essential for monitoring long term trends of key climate variables




## At different spatial and temporal resolution




## Addressing biogeochemical cycles and Earth system interfaces



PROGRAMME OF THE EUROPEAN UNION

co-funded with esa

# Strengthening Copernicus Space with the Sentinel Expansion Missions

## CHIME

Copernicus Hyperspectral Imaging Mission for the Environment

soil properties
crop health
raw materials
biodiversity
water quality

## ROSE-L

L-band Radar Observing System

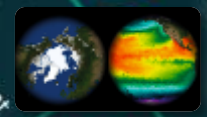
geohazards
polar ice
forest management
food security
maritime surveillance

## LSTM

Land Surface Temperature Monitoring

sustainable agriculture
water resources management
drought
urban heat islands

sea-ice concentration/extent
global ocean and cryosphere
soil moisture and vegetation



## CIMR

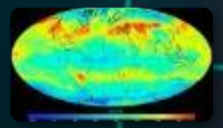
Copernicus Imaging Microwave Radiometer

Food Security and Water Management

Monitoring Land and Natural Resources

## CO2M

Copernicus Anthropogenic Carbon Dioxide Monitoring



carbon dioxide and methane from human activity

Combatting Climate Change

Copernicus Sentinel Expansion Missions

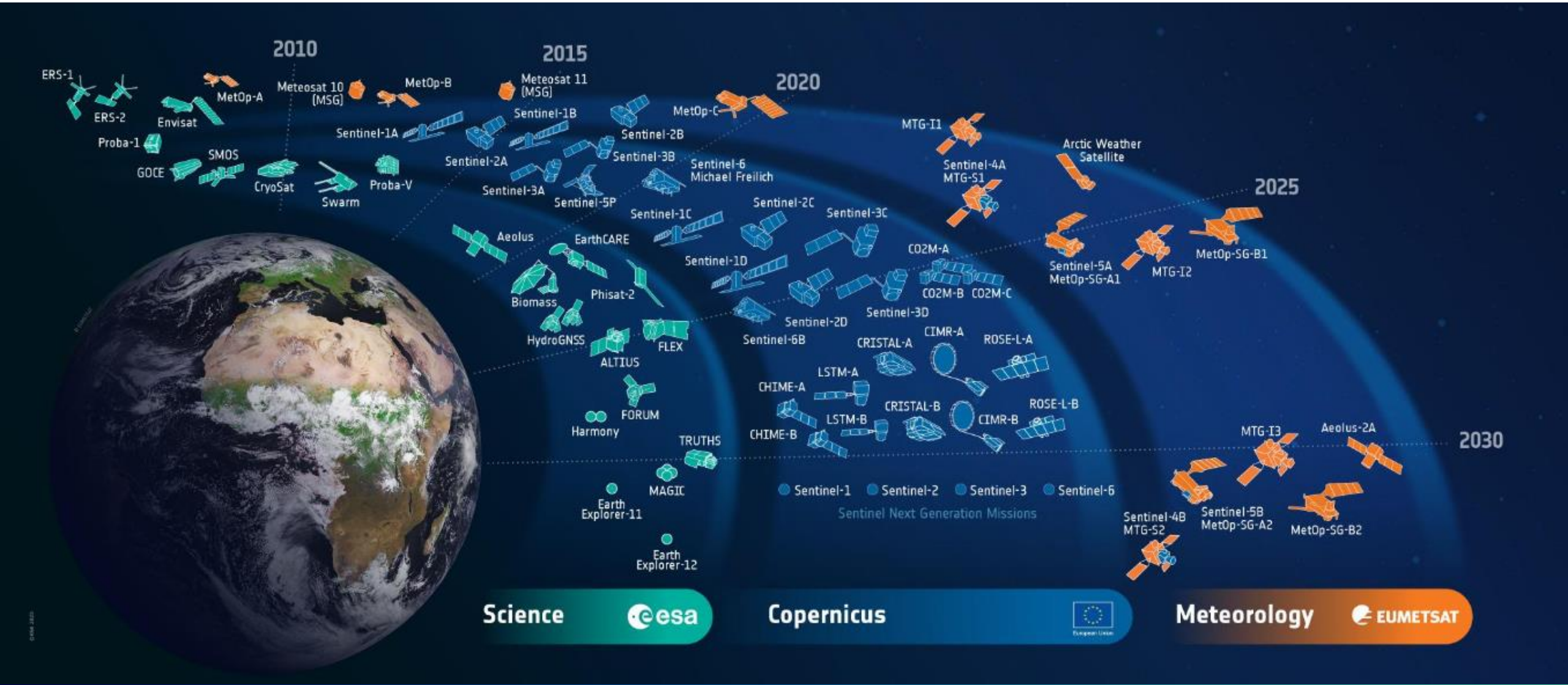
Safeguarding the Arctic

## CRISTAL

Copernicus Polar Ice and Snow Topography Altimeter

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

# A necessary continuum and integration between European EO programmes



# The Copernicus contributing missions

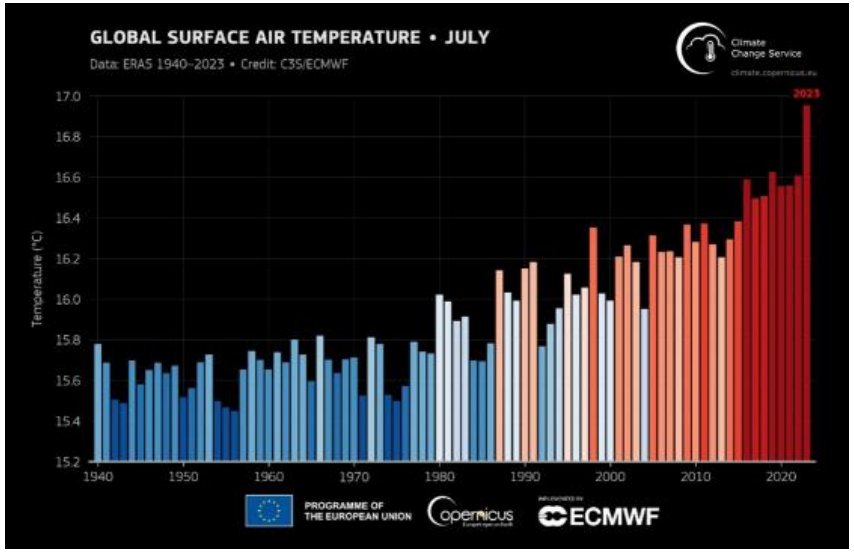

 

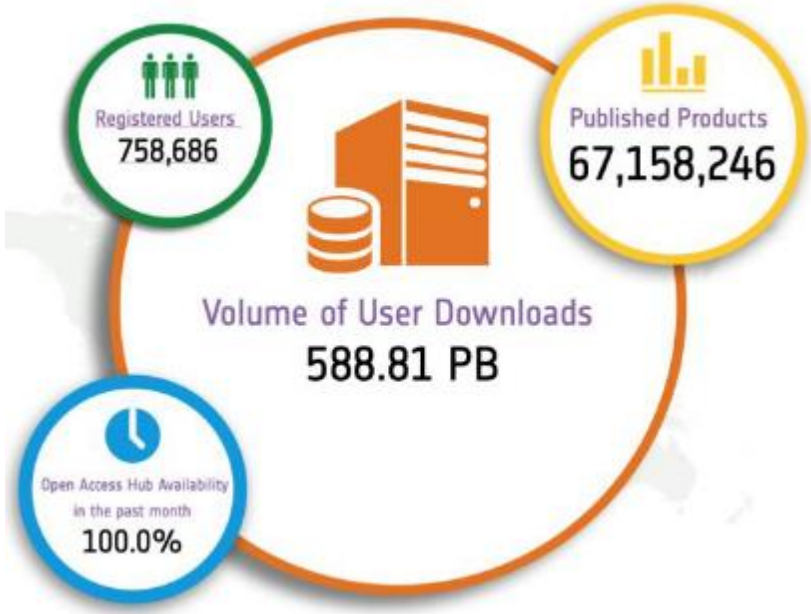

opernicus
CLIMATE CHANGE
MARINE MONITORING
ATMOSPHERE MONITORING
LAND MONITORING
SECURITY
EMERGENCY MANAGEMENT


PROGRAMME OF THE EUROPEAN UNION
opernicus
Europe's eyes on Earth
co-funded with
esa
EU Forest Strategy for 2030
European Climate Law
Strategy on adaptation to climate change
Nature Restoration Law
A renewed EU Arctic Policy
EU Soil Strategy for 2030
Zero Pollution Action Plan
Common Agricultural Policy
EU Action to Protect and Restore the World's Forests
Net-Zero Industry Act
and others...
SENTINEL-6
SENTINEL-5
SENTINEL-5P
SENTINEL-4
SENTINEL-3
SENTINEL-2
LSTM
CIMR
CO2M
CHIME
ROSE-L
CRISTAL
Copernicus supports EU policies and the Green Deal
→ THE EUROPEAN SPACE AGENCY

# Copernicus, world leader for monitoring the state of the planet

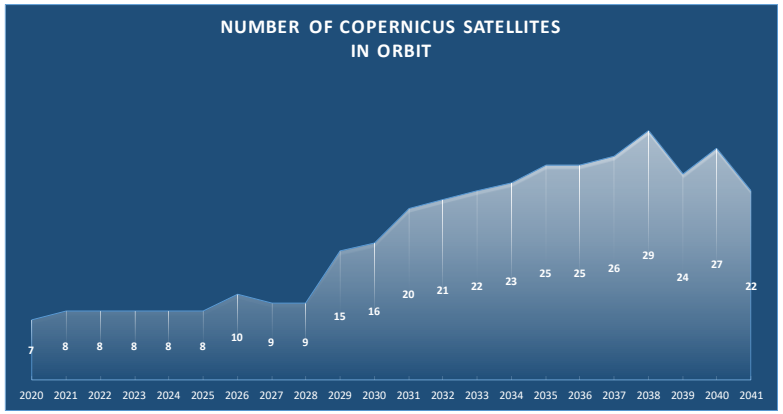
- **Continuum between research and services / downstream applications**: the scientific community is a key actor for specifying the space missions and for supporting the development of services and products, with two priorities: improved continuity of observations, and increased spatial and temporal resolution
- **Trust and reliability** with a guaranteed continuity, data and service quality, transparency and long term visibility
- **International reference** for UN COP meetings and for the international community (most research projects on the Earth system are using Copernicus data)
- Soon **800 000 users**, 600 PB of data downloaded



# Future challenges

- **Safeguarding top operational priorities**: improved continuity, data and information access under a full, free and open basis




- **Ensuring sustainability** with increasing costs for operating 12 Sentinel families in a context of growing needs of European space programmes (resilience and security, new programmes such as IRIS², governmental services…)

- **Defining a good balance between « *Make or buy* »** : hybrid approach combining reference missions (Sentinels) and contributing missions / Newspace

- **Reinforcing governance** : EU, ESA, EUSPA, dual use for governmental services

# Concluding remarks

- **Copernicus : flagship of the EU, outstanding international success international** strongly relying on previous and long term research activities for specifying space-based observing systems and developing operational services with high quality data
  ➔ observing, understanding, modelling, predicting and scenario analysis (Digital Twin Earth)

- **The unstinting Sentinels are real game changer**, enabling outstanding new developments in so many scientific and economic domains

- **Enhanced continuity is key** for monitoring the essential climate variables and understanding global change processes, including improved spatio-temporal resolutions

- **Calibrated/validated observations** are crucial for the quality of output information

- **State-of-the-art services** cannot be maintained without the continuous involvement of research