Copernicus

General Overview

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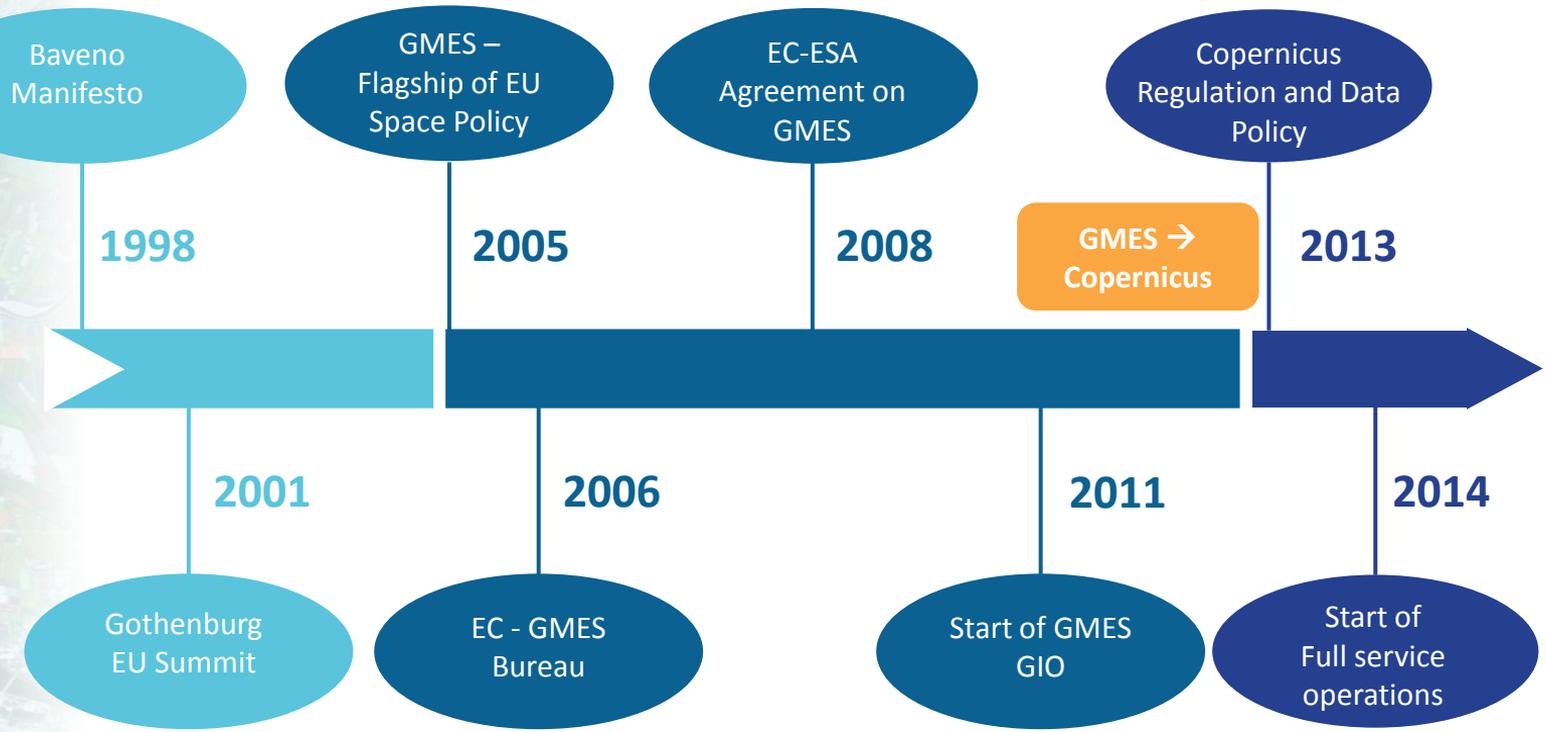European Commission

Copernicus
Europe's eyes on Earth

- **Copernicus is a flagship programme** of the European Union:

  – Monitors **the Earth,** its environment and ecosystems

  – Prepares for **crises, security risks** and **natural or man-made disasters**

  – Contributes to the **EU's role as a global soft power**

- a **full, free and open data policy**

- Is a tool for **economic development** and a driver for the **digital economy**

COPERNICUS HISTORY

Baveno Manifesto

GMES – Flagship of EU Space Policy

EC-ESA Agreement on GMES

Copernicus Regulation and Data Policy

1998

2005

2008

GMES → Copernicus

2013

2001

2006

2011

2014

Gothenburg EU Summit

EC - GMES Bureau

Start of GMES GIO

Start of Full service operations

GIO = GMES Initial Operation

Copernicus

From research to operations

GMES: R&D funded activities under FP7

Preparatory actions

GIO:Initial Operations

Dedicated satellites

Copernicus operational programme

Operational services

2008

2011

2014

2020+

€1.3Bn

€4.3Bn

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European Commission

Programme Manager

SPACE

TECHNICAL COORDINATION BY
esa

SENTINELS MISSIONS OPERATED BY
esa   EUMETSAT

CONTRIBUTING MISSIONS
Participant States

SERVICES

IMPLEMENTED BY

ECMWF

MERCATOR OCEAN

European Environment Agency

ECMWF

EMSA   FRONTEX

IN SITU

Participant States

COORDINATED BY
European Environment Agency

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Estimated direct monetary benefits between 2008 and 2020

EUR 13.5 billion

EUR 7.4 billion

Downstream and end users*	EUR 3.1 billion
Upstream and Copernicus Services	EUR 10.3 billion

Overall investment in the programme

Cumulated economic benefits
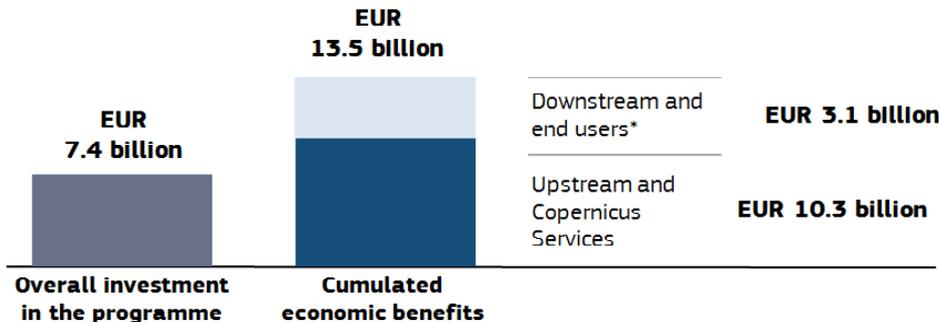
12,450 job years supported in the downstream and end user markets

15,580 jobs years supported in the upstream

Examples of existing Copernicus benefits

70% Cost reduction of a precision farming service in Austria, thanks to Copernicus

€ 60k Yearly savings for each construction company using a work progress monitoring app
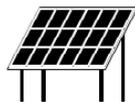
60% Higher accuracy for analysis of the impact of trans-boundaries pollutants on air quality

5% Productivity gain for fish farmers, by monitoring toxic algal blooms

50% Copernicus-based forecasts generate 50% more benefits to solar energy producers than traditional forecasts

€ 186M Benefits of Copernicus on the insurance market in 2015

* The Downstream and end user analysis includes only 8 value chains: Agriculture, Forestry, Urban Monitoring, Insurance, Ocean Monitoring, Oil & Gas, Renewable Energies and Air Quality. Estimates for end users were only calculated for Insurance, Oil&Gas and Urban Monitoring. The estimates of downstream and end user benefits should be seen as extremely conservative because they were calculated a year after the launch of the first Sentinel satellite. Benefits are likely to increase significantly as more

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Climate change & Environment

Development & Cooperation

Security & Defence

Tourism

Health

Insurance & Disaster management

Blue economy

Urban planning…

Energy & Natural resources

Forestry…

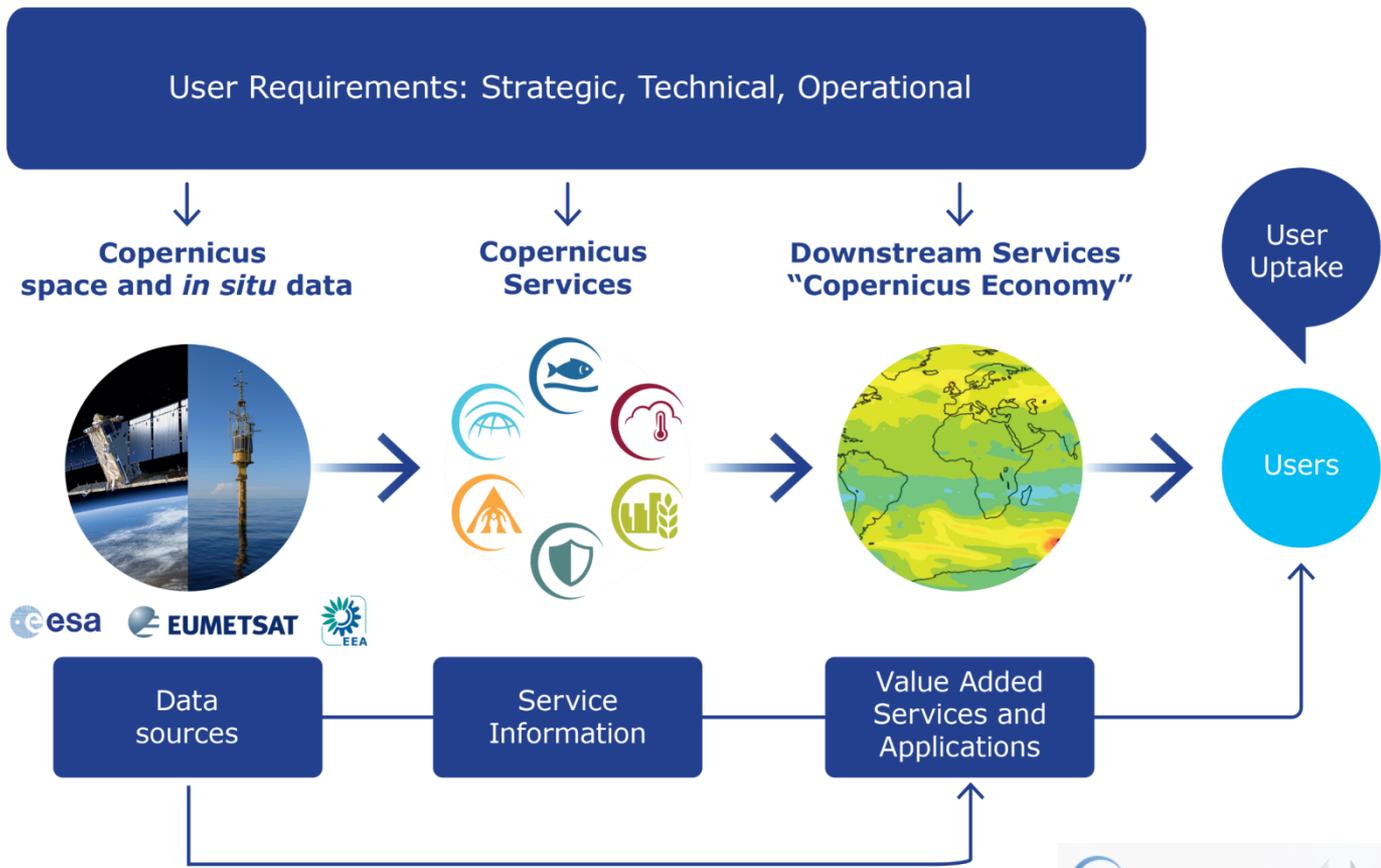|		
	Pipeline Infrastructure Monitoring in the Netherlands	Benefits for the Netherlands: €15 to €18 M/year
	Forest Management in Sweden	Benefits for Sweden: €16 to €22 M/year
	Winter Navigation in the Baltic	Benefits for Sweden and Finland: €24 to €106 M/year

Source: EARSC

User Requirements: Strategic, Technical, Operational

Copernicus space and *in situ* data

Copernicus Services

Downstream Services "Copernicus Economy"

User Uptake

Users

esa EUMETSAT EEA

Data sources	Service Information	Value Added Services and Applications

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Space Component

FULL, FREE AND OPEN

Sentinel Mission and Status

Mission	Status
SENTINEL-1: 9-40m resolution, 6 days revisit at equator	*S1-A and B in orbit*
SENTINEL-2: 10-60m resolution, 5 days revisit time	*S2-A in Orbit S2-B in Orbit*
SENTINEL-3: 300-1200m resolution, <2 days revisit	*S3-A in Orbit S3-B Launch Q4 2017*
SENTINEL-4: 8km resolution, 60 min revisit time	*1st Launch Q4 2022*
SENTINEL-5p: 7-68km resolution, 1 day revisit	*Launch in Q2 2017*
SENTINEL-5: 7.5-50km resolution, 1 day revisit	*1st Launch in 2021*
SENTINEL-6: 10 days revisit time	*July 2020*
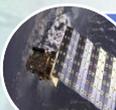
Key Features

- Polar-orbiting, all-weather, day-and-night radar imaging
- Polar-orbiting, multispectral optical, high-res imaging
- Optical and altimeter mission monitoring sea and land parameters
- Payload for atmosphere chemistry monitoring on MTG-S
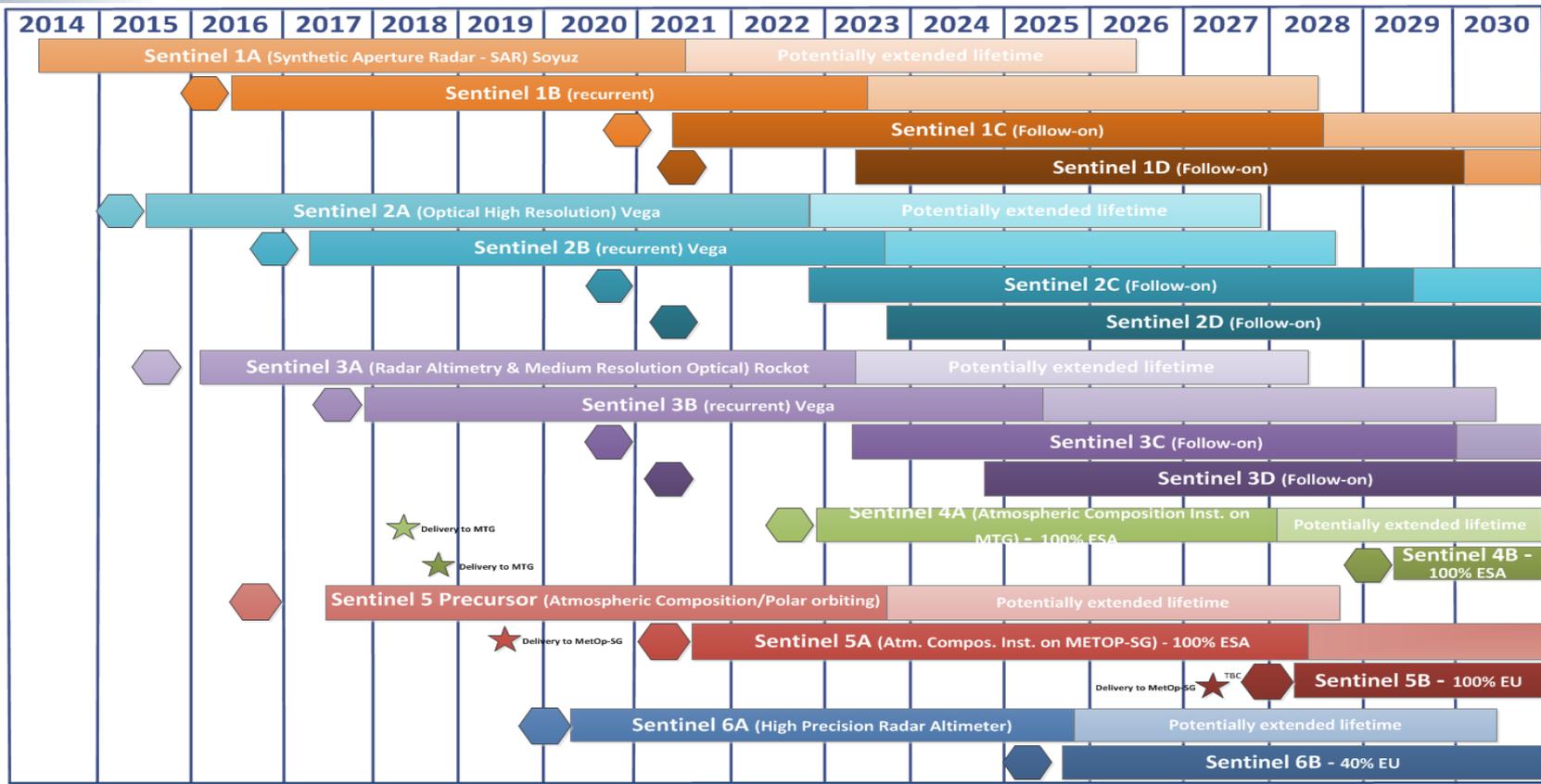- Mission to reduce data gaps between Envisat, and S-5
- Payload for atmosphere chemistry monitoring on MetOp 2ndGen
- Radar altimeter to measure sea-surface height globally

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SENTINEL FAMILY DEPLOYMENT SCHEDULE

Space Component

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |

- Sentinel 1A (Synthetic Aperture Radar – SAR) Soyuz — Potentially extended lifetime
- Sentinel 1B (recurrent)
- Sentinel 1C (Follow-on)
- Sentinel 1D (Follow-on)
- Sentinel 2A (Optical High Resolution) Vega — Potentially extended lifetime
- Sentinel 2B (recurrent) Vega
- Sentinel 2C (Follow-on)
- Sentinel 2D (Follow-on)
- Sentinel 3A (Radar Altimetry & Medium Resolution Optical) Rockot — Potentially extended lifetime
- Sentinel 3B (recurrent) Vega
- Sentinel 3C (Follow-on)
- Sentinel 3D (Follow-on)
- Sentinel 4A (Atmospheric Composition Inst. on MTG) – 100% ESA — Potentially extended lifetime
- Sentinel 4B – 100% ESA
- Sentinel 5 Precursor (Atmospheric Composition/Polar orbiting) — Potentially extended lifetime
- Sentinel 5A (Atm. Compos. Inst. on METOP-SG) - 100% ESA
- Sentinel 5B – 100% EU
- Sentinel 6A (High Precision Radar Altimeter) — Potentially extended lifetime
- Sentinel 6B - 40% EU

Delivery to MTG
Delivery to MTG
Delivery to MetOp-SG
Delivery to MetOp-SG   TBC

Legend: ⬡ Flight Acceptance Review

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Space Component

Key Features:

- SAR sensor - All-weather, day-and-night
- 9-40m resolution, 6 days revisit time at equator
- 2 launched on 3/4/2014 and 25/4/2016, 2 ordered

Contributes to:

Copernicus Land Monitoring Service

Copernicus Marine Environment Service

Copernicus Emergency Management Service

Copernicus Climate Change Service

Copernicus Security Service

Space Component

Key Features:
- Multispectral optical sensor
- 10-60m resolution, 5 days revisit time
- First unit launched on 22/6/2015
- Second launched on 7/03/2017
- 2 more units are ordered

Contributes to:

 Copernicus Land Monitoring Service

 Copernicus Emergency Management Service

 Copernicus Climate Change Service

 Copernicus Security Service

Space Component

Key Features:

- Medium resolution imaging and altimetry
- 300-1200m resolution, <2 days revisit time
- Monitors Sea and Land Surface Parameters
- First unit launched on 16/2/2016
- Second unit to be launched in Q4 2017
- 2 more units ordered

Contributes to:

Copernicus Land Monitoring Service

Copernicus Marine Environment Service

Copernicus Climate Change Service

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Space Component

Key Features:
- Onboard MTG-S
- Atmospheric Chemistry Mission
- 8km resolution, 60 min revisit time
- To be launched in 2022

Contributes to:

Copernicus Atmosphere Service

Copernicus Climate Change Service

Space Component

Key Features:

- Precursor of Sentinel-5
- Atmospheric Chemistry Mission
- 7-68km resolution, 1 day revisit time
- To be launched by mid-2017

Contributes to:

Copernicus Atmosphere Service

Copernicus Climate Change Service
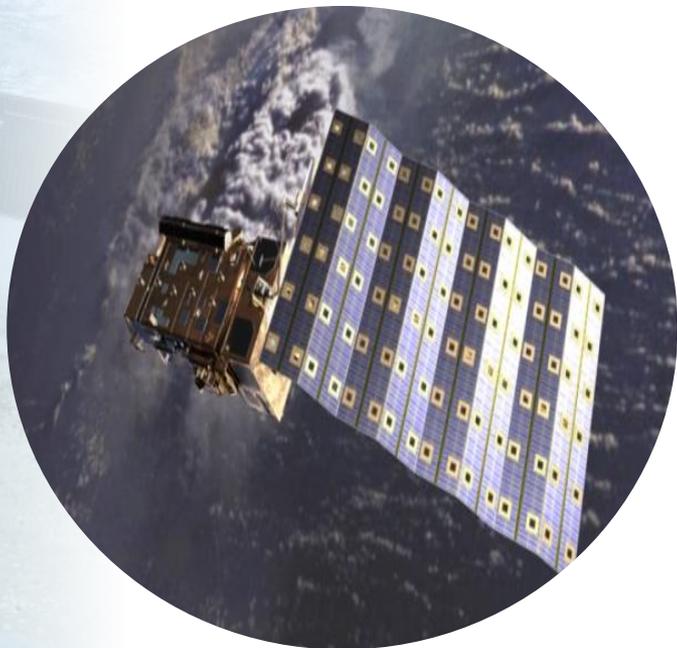
Space Component

Key Features:
- Onboard MetOp 2nd Gen
- Atmospheric Chemistry Mission
- 7-50km resolution, 1 day revisit time
- To be launched in 2021

Contributes to:

 Copernicus Atmosphere Service

 Copernicus Climate Change Service

Space Component

Key Features:
- Radar Altimeter
- Measures sea-surface height
- 10 days revisit time
- To be launched in 2020

Contributes to:

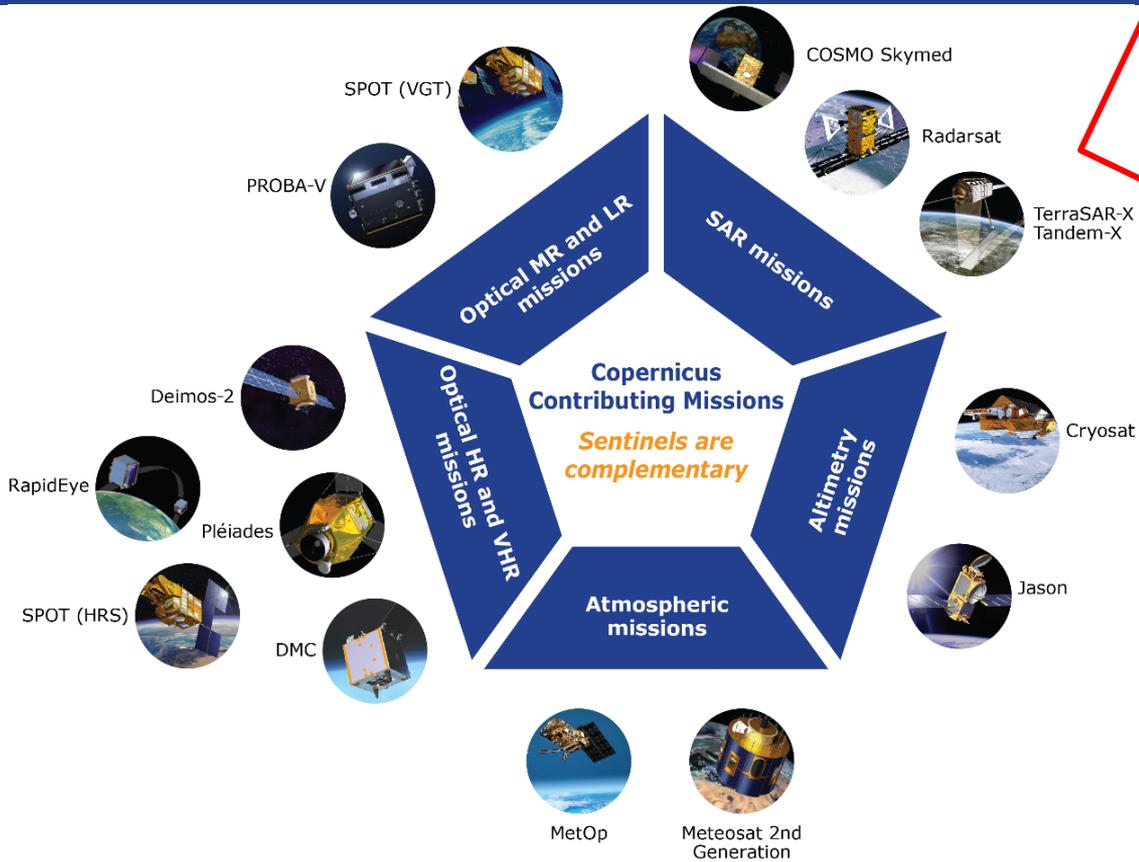Copernicus Marine Environment Service

Copernicus Atmosphere Service

Copernicus Climate Change Service

Space Component

COSMO Skymed

SPOT (VGT)

Radarsat

PROBA-V

TerraSAR-X
Tandem-X

Subject to Data Owner's Data Policy

Optical MR and LR missions

SAR missions

Deimos-2

Copernicus Contributing Missions

Sentinels are complementary

Cryosat

RapidEye

Optical HR and VHR missions

Altimetry missions

Pléiades

SPOT (HRS)

Jason

DMC

Atmospheric missions

MetOp

Meteosat 2nd Generation

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In situ

- *In situ* data = observation data from ground-, sea-, or air-borne sensors, reference and ancillary data licensed for use in Copernicus
- Use of *In situ* data:
  - Validate & calibrate Copernicus products
  - Reliable information services
- Implementation in two tiers:
  - Tailored *in situ* data for each Copernicus service level
  - Cross-cutting coordination across services by the EEA

Monitoring the State of the Earth System Environment ...

... Six cross-cutting Thematic Services

SERVICES IMPLEMENTATION SCHEDULE

	2014	2015	2016	2017	2018	2019	2020

EEA — Land Monitoring – Pan-European and Local

JRC — Land Monitoring – Global

MERCATOR OCEAN — Marine Environm. Monitoring Phase I — Phase II

ECMWF — Atmosphere Monitoring Phase I — Phase II

ECMWF — Climate Change – Phase I — Phase II — Phase III

JRC — Emergency Management

FRONTEX — Security – Border Surveillance

EMSA — Security – Maritime Surveillance

EUSC — Security – Support to External Action

EEA — In-Situ Coordination

Legend: ⬡ Delegation agreement △ Direct Management ◯ Operationnal phase

Land Monitoring

Ecosystems

Biodiversity

Agriculture

Forestry

Energy

Natural Resources

Water

Urban planning

Global

Pan-European

EU Land Cover

Specific land cover info

Hydrographic and elevation reference maps

% of built-up area
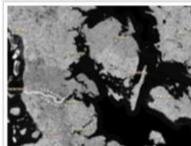
Image Mosaics | CORINE Land Cover | High Resolution Layers | Reference Data | Related Pan-European products
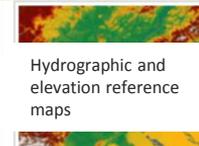
Local
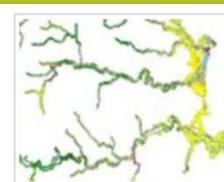
Urban Atlas | Riparian Zones | Natura 2000 (N2K)

Benefit areas and products examples

Marine safety

Marine resources

Coastal and marine environment

Climate and meteorological forecasting

Other: Transport, Tourism, Environment, Pollution, Energy, etc.

Sea Level

Ocean Salinity

Ocean Temperature

Sea Ice

Wind

Ocean Currents

Ocean Colour / Biogeochemistry
(e.g. optics, chlorophyil, biology, chemistry)

Atmosphere
Monitoring

Health

Environment

Pollution

Climate

Renewable Energy

Air Quality and Atmospheric Composition

Climate forcing

Ozone layer & UV

Solar radiation

Emissions and surface fluxes

Climate Change

Climate change

Mitigation and adaptation

Weather forecast

Pollution

Environment

Health

Consistent Estimates of the Essential Climate Variables (ECVs)

GCOS Essential Climate Variables

Support to Mitigation and Adaptation Strategies

Global and Regional Reanalyses
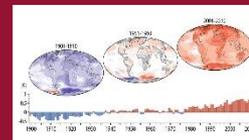
Seasonal Forecasts And Climate Projections

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Emergency Management

Disaster Emergency Situations

Humanitarian Crises

RESILIENCE

RECOVERY

EMERGENCY RESPONSE

PREPAREDNESS

Risk & Recovery Mapping:
- **Reference Maps**
- **Pre-disaster Situation Maps**
- **Post-disaster Situation Maps**

Rapid Mapping:
- **Reference Maps**
- **Delineation Maps**
- **Grading Maps**

Early Warning:
- **Floods: EFAS**
- **Forest Fires: EFFIS**

EFAS = European Flood Awareness System;
EFFIS=European Forest Fire Information System

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Security

Border Surveillance

- Coastal monitoring
- Pre-frontier monitoring
- Reference mapping

Maritime Surveillance

- Maritime surveillance of an area of interest
- Vessel detection
- Vessel tracking and reporting
- Vessel anomaly detection

Support to EU External Action

- Road network status assessment
- Conflict damage assessment
- Critical infrastructure analysis
- Reference map
- Support to evacuation plans
- Crisis situation map
- Border map
- Camp analysis

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User Uptake

*More affordable applications based on **Free Sentinels 1 and 2 Data and the Land Service Products***

- **Precision farming** applications such as yield mapping, input management, farm management recording, etc.
- **Seasonal mappings** of cultivated areas
- **Field scale and crop dynamics** mapping
- **Irrigation management** and drought monitoring
- **Food security** monitoring
- **Agriculture development** in Africa

€78M — More efficient use of agricultural inputs

Better quality food production

More efficient and appropriate use of fertilizers

€ Expected Copernicus enabled revenues

Sources: PwC-Strategy& analysis & European Commission

User Uptake

Improving irrigation management in Austria with Copernicus

Irrigation cost for one year: **8 M€ to 20 M€**

Improvements through optimisation of the **amount of water requirements** + optimisation of the **distribution of individual irrigation events**.
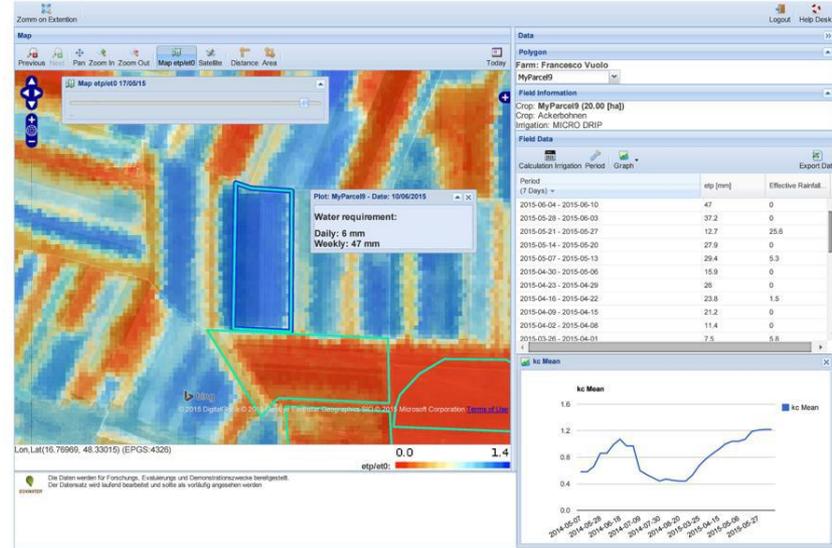
Products delivered:
- **crop development maps**
- **evapotranspiration maps**
- **weather data and forecast**

Extract of the webGIS information used to deliver the information to farmers
(Source: Institute of Surveying, Remote Sensing and Land Information)

23% reduction of the total service cost enabled by Sentinel data (compared to commercial satellites)

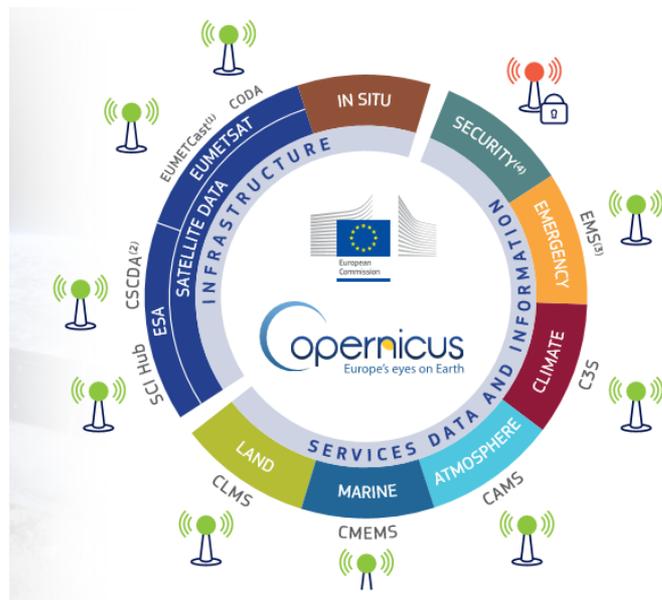*Sources: PwC-Strategy& analysis & European Commission*

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User Uptake

- Satellite Data distribution Hubs
  - Sentinels
  - Contributing missions
  - Access to images in NRT
  - Access to archives

- Services Information portals for
  - Added value products, indicators
  - Models
  - Archives, Near Real Time and Forecasts products

Note: *Copernicus in situ component provides in situ data access, serving the Copernicus services. It is not delivering in-situ data to the end-users.*

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User Uptake

Access to Satellite data

esa

FULL, FREE AND OPEN

sentinel data hub

Scientific and Other Access

https://scihub.copernicus.eu/

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esa

CSC data access

Copernicus Space Component Data Access Portal*
CSC-DA

https://spacedata.copernicus.eu/

EUMETSAT

FULL, FREE AND OPEN

- Copernicus Online Data Access (CODA)

- EUMETCast:
  www.eumetcast.com
  Needs to get a station and pay a yearly fee

Access to Copernicus Services Data

FULL, FREE AND OPEN

- Land-related data: http://land.copernicus.eu
- Atmosphere-related data: http://atmosphere.copernicus.eu
- Marine-related data: http://marine.copernicus.eu
- Emergency-related data: http://emergency.copernicus.eu
- Climate change-related data: http://climate.copernicus.eu (Beta version)

(*) Includes instructions on how to access Contributing Missions data

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User Uptake

- **Massive amounts of data**
- **Full, open and free-of-charge**
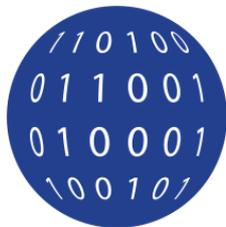
Over 10 Petabyte/year of new data
with just Sentinels-1, -2 and -3 fully operational (data are downloaded **many time over)**

- Different types of **dissemination** infrastructures
- **New technology** developments
- ICT and EO **cross-fertilisation**
- **Interoperability** with non-EO datasets
- Global EO **competition**
- Growth and jobs in **downstream** sector

User Uptake

Dual approach:

- Strong Copernicus Distribution Services for download

- Imminent launch of several **Data Access and Information Services (DIAS)**

    – **Access to all Copernicus data and information collocated with computing resources**

    – **Big Data analytics without the need to download the data and information**

    – **Data fusion with non-EO data and information**

Overall **ensuring that Copernicus data is easily accessible and used!**

User Uptake

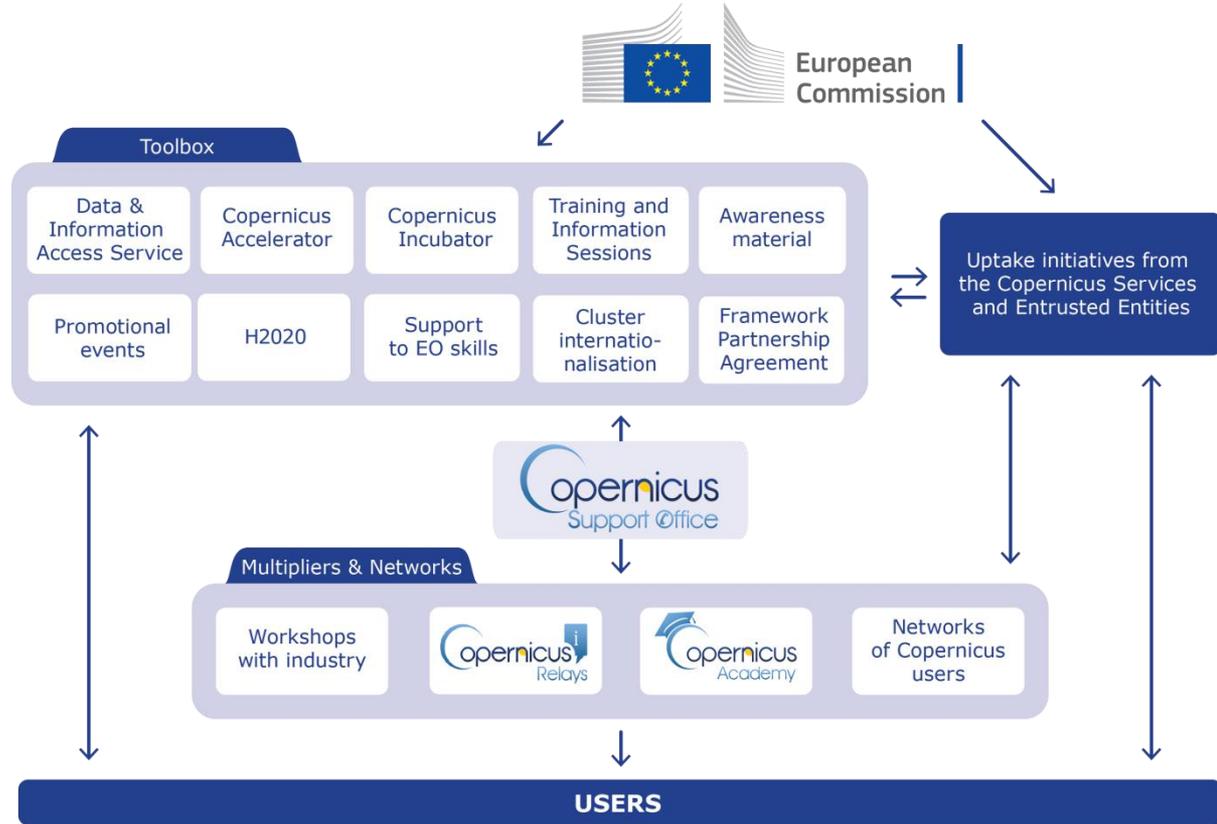Promote the uptake of Copernicus data and services

1

Ensure Access

2

Boost Innovation

3

Increase Awareness And Use

Upstream & Midstream

Downstream

Users

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Toolbox

Data & Information Access Service	Copernicus Accelerator	Copernicus Incubator	Training and Information Sessions	Awareness material
Promotional events	H2020	Support to EO skills	Cluster internatio-nalisation	Framework Partnership Agreement

Uptake initiatives from the Copernicus Services and Entrusted Entities

Copernicus Support Office

Multipliers & Networks

Workshops with industry	Copernicus Relays	Copernicus Academy	Networks of Copernicus users

USERS

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https://www.youtube.com/watch?v=MGJss4lDaBo

Protect people and assets

Increase general knowledge on the state of the Planet

The Union Earth Observation and monitoring programme

Improve environmental policy effectiveness

Monitor the environment

Facilitate adaptation to climate change

Foster downstream applications in a number of fields

Help managing emergency and security related situations

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