ESA Council at Ministerial Level (CM22) Earth Observation programme package

Belgian info Day, 30/09/2022, Antwerpen

Michel Verbauwhede, ESA EO Directorate
Promoting cooperation among European States in space research, technology and applications, for exclusively peaceful purposes.

22+ Member States
Doing together what none can do alone
Council at Minister Level meets every 3 years to define and subscribe to the future ESA programmes

We need a successful CM22 to face the Global challenges for 2023-2026 and beyond and ensure European strategic autonomy

AN EO PROGRAMME PACKAGE THAT IS:

- ESSENTIAL
- URGENT
- EO-ENABLED
- COLLABORATIVE
- LONG TERM

COHERENT
An ESA Programme is:

A legal container = materialization of a collective will (by Interested Member States) to perform an activity

- Incentive for Member States: scientific return, industrial competitiveness, geo-return, societal relevance
- 95% of ESA EO activities correspond to optional programmes.
- Most of our programmes are spanning several CM cycles

WHAT (activities/deliverables) HOW MUCH (it costs) HOW LONG (it lasts) HOW MUCH I CONTRIBUTE (subscription at CM22)

1 programme ≠1 satellite. Can be (part of) a satellite (and its ground segment and its operations), several satellites, other types of activities (i.e. applications), a combination thereof

22 + Member States doing together what none can do alone
What happens in Arctic doesn’t stay in Arctic

Sovereignty
Climate change
Green transition
Knowledge, science, jobs
Develop world-class Earth Observation systems with European and global partners to address scientific & societal challenges.

**ESA’s Earth Observation Mission**

- **Missions**
  - 15 in operation
  - 39 in development
  - 12 in preparation

*Pending final mission selection*
Without EO there is no evidence-based information to measure, monitor and guide global and local initiatives...

We can only manage What we can measure...

With EO we can measure
With EO we can manage
Cryosat manages first sea ice observations over summer

Scientists found a novel way of removing the problem of glare from surface meltwater.

Resulting in an uninterrupted time-series.
Climate Change affects timing, frequency, size and intensity of wildfires – 30,000 hectares burnt in the Gironde –
Yield Forecast

Ukraine Harvest Progress

17% reduction in expected average yield for winter wheat compared to last 4 year average

- Mostly due to drought that is affecting all of Europe
- Potentially less use of fertiliser due to price increase

53% Non-Active Winter Cropland!
Except we are not here to build satellites, but ultimately to observe our shared Home.
EO Programme
Package for CM22

Pre-operational activities answering demands from user communities, industry, Member States

Earth Science, Preparation of EO future and World-class EO Research Missions

Worldwide data and a walk in the past to better understand the present and the future

Securing the long-term continuation of Europe’s eyes on our planet

FutureEO

BASIC ACTIVITIES

Earthnet
Heritage Space
DPTD

CUSTOMISED EO
COMMERCIALISATION
InCubed 2
TRUTHS
DIGITAL TWIN EARTH (DTE)
CLIMATE-SPACE
METEOROLOGY
Aeolus-2
OPERATIONAL EO
COPERNICUS
Sentinels
Next Gen.

Aeolus-2

DIGITAL TWIN EARTH
(DTE)

CLIMATE-SPACE

TRUTHS

CUSTOMISED EO

COMMERCIALISATION
InCubed 2

METEOROLOGY
Aeolus-2

OPERATIONAL EO
COPERNICUS
Sentinels
Next Gen.
EO is not just a tree

EO is an Ecosystem

BASIC ACTIVITIES
- Earthnet
- Heritage Space
- DPTD

BUSINESS
- Upstream Industry
- Downstream Industry
- SMEs

TRUTHS
- Digital Twin Earth (DTE)

INTERNATIONAL AGENDAS
- COP26
- Green Deal
- Biodiversity
- Paris Agreement
- Urban Soil Sealing
- Air Quality

APPLICATIONS
- Natural Services
- International research institutions
- Universities

INTERNATIONAL COOPERATION
- International research institutions
- National research labs

SERVICES
- Applications

SCIENCE
- Natural Services

INTERNATIONAL COOPERATION
- Droughts
- Renewable Resources
- Food Security
- Water level

IPCC & CLIMATE
- Aeolus-2

METEOROLOGY
- Droughts
- Renewable Resources
- Food Security
- Water level

OPERATIONAL EO
- COPERNICUS Sentinels
- NGOs
- UN (e.g. FAO, WFP, IFAD)

ORGANISATIONS
- CEOS
- NASA
- JAXA
- ISRO
- SANSA
- EC
- EUM

CUSTOMISED EO
- IPCC & CLIMATE

COMMERCIALISATION
- InCubed 2

INTERNATIONAL COOPERATION
- SMEs

FutureEO
- Climate
- Truths

CUSTOMISED EO
- IPCC & CLIMATE

COMMERCIALISATION
- InCubed 2
Assess the attractiveness of ESA CM22 EO programmes

Understand the size, dynamism and resilience of the European EO “ecosystem”

Understand where industry would like to be at horizon 2030+

Identify new ways to co-work with Industry

Eurospace-led ESA-industry dialogue ahead of CM22

280 Registered participants
48 Panellists and speakers

Graph showing the number of registered participants from different countries.
Eurospace-led ESA-industry dialogue ahead of CM22

**General feedback**

Good satisfaction level with the event
- Stakeholders note that the ESA-industry dialogue initiative enables to bridge the information gap
- Supply chain believes that more information generates more political support

**ESA EO proposal feedback**

All programme components receive good ratings on the 4 criteria proposed

Overall Future EO is the best voted programme by all. Probably because of its budget relevance for most players

**Trends and conclusions survey**

The survey reveals that respondents are well aligned with the conclusions of the Seminar

Strong support of all the statements proposed in the Seminar synthesis
## Progress of Preparation

<table>
<thead>
<tr>
<th>Programme</th>
<th>Readiness</th>
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<tbody>
<tr>
<td>FutureEO-1s2</td>
<td>Entire document package for CM22 is finalised (Programme proposal, Declaration and Implementing Rules)</td>
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<tr>
<td>CSC4-ph2</td>
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<tr>
<td>Aeolus-2</td>
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<td>EW – TRUTHS</td>
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<td>EW – InCubed</td>
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<td>EW – Climate Space</td>
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<td>EW – Digital Twin Earth</td>
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</table>

All proposals received positive internal review
FutureEO - Since 2000: ESA’s core Earth Observation research and development programme

Earth Science, Preparation of EO future and World-class EO Research Missions

The only ESA (EO) optional programme bringing together all Member States

EOP locomotive at CM22
FutureEO-1 Segment 2 – The rationale behind

The backbone ESA Earth Observation programme for Earth Science – unique selling points

✓ World class Research missions - supporting Earth Explorers entire cycle
✓ Preparing all desirable EO Future
✓ Bringing together science – technology - application
✓ Cooperation with international actors of the sector

FutureEO-1 Segment 2 will keep the essential features of its precursors:

✓ Flexibility of an envelope approach
✓ Driven by scientific excellence and technological innovation
✓ Financing implementation of at least one world-class research mission per 3-year segment
✓ Long-term vision with continuity
FutureEO – Earth Explorers

**Flying Missions**
- GOCE (2009-2013)
- SMOS (2009)
- Cryosat (2010)
- Swarm (2013)
- Aeolus (2018)

**Future Missions**
- EarthCARE (2023)
- Biomass (2023)
- FLEX (2024)
- FORUM (2027)
- Harmony (2029)

**Science & Innovation**
- 1,200+ Active Users
- 400+ Publ. per Year

**High Risks for Great Rewards**
FutureEO-1 Segment 2 – Key highlights

The Research Missions
- Implement BoostFutureEO early phases
- Implement Harmony as Earth Explorer 10
- Prepare candidate missions for Earth Explorer 11 – Wivern, Cairt, SEASTAR, Nitrosat (up to selection prior to CM25)
- Calls for EE 12 & 13 candidate missions
- Implement Next Generation Gravity Mission
- 2nd Scout challenge and implementation (Scout 3 and 4)
- Operate and manage growing amount of EEs in orbit

Paving the way to the future
- Combining Mission Feasibility with enabling Technology & Science and Campaigns
- Prepare the whole EO family of missions
  - The Research Missions (cf above)
  - Copernicus Sentinel Next Generation missions (Sent-2-NG and Sent-3NG Opt)
  - Meteosat Fourth Generation and MetOp Third Generation missions
- Further science, applications and downstream industrial competitiveness
  + Enhanced “Generic Preparation of the Future” and “Instrument Pre-development”
FutureEO-1 Segment 2 – Foundations and Concepts

**Mission Feasibility**

- EE-12 ≤ 5 mission concepts in Phase 0 (+≤ 4 commended missions in maturation pool); ≤ 2 in Ph.A
- 2nd Scout challenge ≤ 4 mission concepts in Feasibility Phase
- Sent-2 and -3 Opt. NG Phase A/B1

**Technology pre-development**

**Instrument pre-development:**
- as part of Mission Feasibility
- support to commended EE-11
- enable new EO concepts (raise TRL)

**Standard Platform + Communications:**
- Incl. reducing recurring costs / operations

**Other Preparatory, e.g. architectural / system studies:**
- Incl. synergies with DPTDE / GSTP for EO
- Meteosat 4th Generation
- Frequency Management

**Science and EE preparation**

**BoostFutureEO:**
- Step-1: Living Planet Challenges
- Step-2: New EO Mission Ideas (NEOMI)
- Step-3/4: Maturation as part of Mission Feasibility

**End-to-End Simulators:**
- as part of Mission Feasibility
- also enable new EO concepts (raise SRL)

**Campaigns**

- THE EUROPEAN SPACE AGENCY
FutureEO-1 Segment 2 – Research Missions

EE10 Harmony

Studyng small-scale motion & deformation fields

(Expected launch 2029)

Two passive receiving antenna satellites
Bi-static SAR + TIR instruments, in stereo and close formation with Sentinel-1, demonstrating synergies between ESA’s EO research missions and EU Copernicus missions

Two satellites flanking Sentinel-1 in stereo or close flight formations

Observing movement in ocean, solid Earth, cryosphere, height-resolved clouds and SST for improved understanding of Ocean circulation patterns, Ice dynamics & mass balance, 3D deformation fields in land topography, Ocean-atmosphere boundary layer
FutureEO-1 Segment 2 – Implementation approach

**HOW**

- Incorporating the strength, experiences and synergies between all activities in EOP
- Working and interacting with National, European and International EO partners

<table>
<thead>
<tr>
<th>Research Mission</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
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<tr>
<td>EE10</td>
<td></td>
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<td>B2/C/D</td>
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<td>Launch</td>
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<tr>
<td>EE11 Candidate Missions</td>
<td>Candidate Mission selection for Phase A</td>
<td>Mission selection + implementation of B1</td>
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<tr>
<td>EE12 Process</td>
<td>Call for EE-12 Mission Ideas (early 2023)</td>
<td>Selection to enter Phase 0 (early 2024)</td>
<td>Candidate Mission selection for Phase A</td>
<td>Mission selection + implementation of B1</td>
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<tr>
<td>EE-13 Process</td>
<td>Call for EE-13 Mission Ideas</td>
<td>Selection to enter Phase 0</td>
<td>Candidate Mission selection for Phase A</td>
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**TIMELINE**

- + 2nd Scout Challenge
- + NGGM/MAGIC
- + Many other activities via the D&E Work Plans

+ THE EUROPEAN SPACE AGENCY
Cooperation framework based on operational coordination and joint data exploitation of 2 satellite pairs developed in parallel with potential exchanges of flight units

**Constellation of two pairs of pre-operational nature:**

- 1\textsuperscript{st} pair, in polar orbit, driven by enhanced continuity (i.e. fast paced, based on GRACE FO technology) in cooperation between NASA/JPL and DLR/GFZ with potential ESA contribution (e.g. MAGIC accelerometer, possibly adapted)
- 2\textsuperscript{nd} pair with inclined and lower orbit and improved measurement system (MAGIC accelerometer) led by ESA with potential NASA/JPL contribution in the Laser Ranging Instrument
- Joint operations of the 2 pairs to demonstrate the value of a constellation to improve spatial and temporal resolutions of gravity field (mass change) data down to sub-regional level
- Future pairs (e.g. for improved operational system in second half of next decade) based on 2\textsuperscript{nd} pair design
FutureEO-1 Segment 2 – Research Missions Scout

Prove small-budget concepts deliver additional science

Very strict cost/schedule boundaries
- 3 years from KO to launch
- Maximum 30 M€ industrial cost

Innovative implementation to ensure fast response
- High TRL and SRL at proposal level
- Service contracts, use of NewSpace approaches
- ESA role focused on critical risks, higher delegation to industry, institutes and labs
- Extensive dialogue during procurement process needed due to quick system studies (6 months)

Main lessons learnt
- Learning journey for the industrial, scientific and ESA teams (e.g. lean project review, agile methodology)
- Dialogue phase is essential to secure the implementation
- Maturity level of the system prime to actually take higher responsibility is a key to success

Current phase: 2 Scouts under implementation
- CubeMAP, launch Q2 2025
- HydroGNSS, launch Q4 2024

2nd Scout challenge in 2023
- Reuse the same process with slight adaptations
- Put more emphasis on the TRL6 roadmap credibility and SRL raising plan
- Clarify expectations – Scout is not a technology IOD but a mission delivering science!
For the first time the parallel operation of 6 Earth Explorer missions, including various missions much beyond their nominal life time (SMOS, CryoSat, Swarm). Plus additionally two Scouts.

Selected future highlights

A growing number of missions in operations

Number of missions in operations
(Swarm mission = 3 satellites)
The four organisation elements of Block 3

Mission-specific operations elements
- Mission space & flight (FOS, PLS)
- Mission data algorithms & quality (DISC)
- Mission data acquisition (acq. stations)
- Mission data (first) processing

Multi-mission operations elements
- Data (re)processing and archiving service
- Data access service
- Web information service
- Cloud & network service
- Development of new multi-mission concepts

Level 2 for Earth Explorers
- Level 2 for missions in development
- Level 2 for missions in operations

R&D for Fiducial Reference Measurements for any EO mission
Earth science for society aims at maximising the impact of European EO assets on society and fostering European competitiveness in the exploitation of all EO missions. The programme is articulated through:

• **4 Core Elements** addressing the needs of the scientific community, sectorial policies and European industry, fostering the transition from science to operations by delivering scientific excellence, pioneering novel applications, growing the downstream sector and leveraging on latest digital platforms and ICT solutions.

• **Supported by 4 Cross-cutting elements**, implemented across the development chain, offering dedicated mechanisms to address specific priorities and needs of MSs, exploring the potential of emerging and disruptive technologies and preparing the community for a new era in EO.

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**Block 4 - Earth Science for Society**

Earth science for society aims at maximising the impact of European EO assets on society and fostering European competitiveness in the exploitation of all EO missions. The programme is articulated through:

- **Core Elements**: Science, Applications, Industrial Competitiveness, Digital Platforms.
- **Cross-cutting Elements**: Rapid EO Solutions, Regional Initiative, Sentinels User Preparation, Foresight.

Open Call for EO Innovation on all Elements.
Investment into space leads to cascading benefits through various adjacent sectors of business

**GDP Impact Assessment**

1€ ↔ 3.47 € to 3.49 €
Depending on period of assessment

**Employment Impact Assessment**

- **Ex Post**
  - EUR 954 M
  - 2589.8 FTE / year
  - 10,359 FTEs

- **Ex Ante**
  - EUR 1,590 M
  - 2465.6 FTE / year
  - 19,725 FTEs

**Summary of Results**
Operational EO

Securing the long-term continuation of Europe’s eyes on our planet

Meteorology - Aeolus-2

Copernicus Sentinels Next Generation
Registered Users, total data download and published products since start of operations

Active Users on Copernicus Open Access Hub for the past month: Distribution by continent

- **Europe**: Active Users 4,129 (Increase/decrease: -40%)
- **Asia**: Active Users 4,136 (Increase/decrease: +15%)
- **North America**: Active Users 1,667 (Increase/decrease: +11%)
- **South America and Antarctica**: Active Users 2,009 (Increase/decrease: +13%)
- **Africa**: Active Users 485 (Increase/decrease: 0%)
- **Oceania**: Active Users 613 (Increase/decrease: -26%)

Volume of User Downloads: 475.95 PB

Registered Users: 595,589

Published Products: 54,262,857

Open Access Hub Availability in the past month: 99.9%
CSC4-Phase2 – Overall scope

Declaration on the Copernicus Space Component (CSC) Programme foresees that Segment 4 of the ESA CSC Programme consists of a coherent overall set of activities, carried out in three, partly overlapping, phases.

Phase 1:
- Phase B2/C/D/E1 of the six High Priority Candidate Missions (HPCMs) (2020-2029)
- Ground Segment (G/S) Development & Collaborative G/S
- CSC coordination activities

Phase 2: Open for subscription at the occasion of CM22.
- Phase B2/C/D/E1 of Sentinel-1 NG and Sentinel-3 Topographic NG (2023-2030)
- Ground Segment (G/S) Development
- CSC coordination activities

Phase 3:
- Phase B2/C/D/E1 of Sentinel-2 / Sentinel-3 Optical NG (2026-2032)
- Phase B2/C/D/E1 of Sentinel-6 NG (Sentinel-6 NG funding for the Phase B2/C/D/E1 will be sought at CM25 as part of a revised CSC-4 Phase 3.)
Aeolus-2 – Programme Proposal Overview

Aeolus-2 is set to succeed and improve upon the highly successful Aeolus Mission, launched in 2018 and demonstrated a significant contribution to the improvement in the accuracy of Numerical Weather Prediction (NWP).

Aeolus-2:

- Collaborative programme with EUMETSAT for a series of two satellites and 10+ years of operations
- Will build on the heritage and experience gained from the Aeolus development/in-orbit operations and an extensive ESA lessons learnt exercise:
  - correction of the observed in-orbit deficiencies
  - an increase of the design lifetime (from 3 years to over 5 years);
  - a (limited) improvement of the observation performances
  - an improvement in the overall robustness and operability
- By EUMETSAT request, Aeolus-2 will also embark a Radio Occultation instrument if feasible.
- First launch planned in 2030
Aeolus-2 – Cooperation Model and Roadmap

Similar ESA-EUMETSAT Cooperation Model for Aeolus-2 as followed on MTG and MetOp-SG:

• ESA is responsible for the development of the space segment and, on behalf of EUMETSAT, for the procurement of the recurrent satellite.

• EUMETSAT is responsible for the end user requirements, the overall system, development of the ground segment, operations and procurement of the launch services for all satellites.

• EUMETSAT will provide a fixed financial contribution (30%) to the ESA development programme (for Phase C/D/E1, but not for Phase B2).

• As Aeolus-2 recurrent Satellites are funded by EUMETSAT, Participating States to the ESA Aeolus-2 Programme will automatically benefit from increased industrial return on the recurrent Satellite.
Pre-operational activities answering demands from user communities, industry, Member States
The International Climate Network

Policy Drivers

- UNFCCC Paris Agreement/ IPCC
- 2030 Agenda for Sustainable Development
- Sendai Framework for Disaster Risk Reduction 2015-2030
- EU’s Green Deal
- UN conventions: biodiversity & ecosystems
- Requirements from various stakeholders of the international climate network, in particular GCOS

Focus on collaboration, complementarity and synergy
Climate-Space – ESA’s role…

**INPUT**
Addressing requirements from international climate network and drivers, such as GCOS, WCRP, UNFCCC, IPCC, climate services/C3S, State of the Climate reports.

**ECVs/CDRs:**
- **OCEAN & CRYOSPHERE**: SST, SSS, OC, Sea State, Sea Level, Sea Ice, Glacier, Ice Sheet
- **ATMOSPHERE**: GHG, LL GHG, Ozone, Aerosol, pre-cursor Aerosol/Ozone, Water Vapour
- **TERRESTRIAL**: LST, MR & HR Land Cover, Lakes, Soil Moisture, Snow, Biomass, Permafrost, Fire

**UNFCCC Paris Agreement**
- Support to climate modelling
- Support Member States in responding to the requirements of the UNFCCC Paris Agreement
- Linking observation and modelling community: CMIP IPO, CMUG, CMIP7+

**R&D and Services**
- R&D: cycles, tipping points, trends, cross ECV, R&D and pre-operational development for climate services
- State of the Climate, IPCC, WMO etc

**High-quality CDRs**
- Scientific evidence base

**OUTPUT**
- Knowledge Exchange: data access & curation, communication, education and outreach
- Delivering Climate Observations to Society
- Climate Ambassador

**International Climate Network**
UNFCCC | IPCC | GCOS | WCRP | Future Earth | CEOS | CGMS | GEO | EUMETSAT | ECMWF | C3S | SCO | CMIP ...
InCubed 2 – Model and roadmap

‘Investing in Industrial Innovation’ to stimulate and develop European Commercial EO

- The InCubed EW Element comprises InCubed (2016/7), InCubed+ (2019) and now InCubed 2 (2022)
- InCubed is a co-funded programme as it is anticipated that industry will be generating revenue from EO products and/or services developed with InCubed
- The end point is at least a minimum viable product to showcase the EO product or service to potential customers or investors

Activities range:
- End-to-end systems developing more competitive technical solutions for existing markets
- Development of software to exploit new markets using existing data streams
- Spin-in of technologies to address EO needs
- In-orbit technologies that support the unique needs of EO systems
- Flight elements that complement the Copernicus and meteo public infrastructure with a commercial focus
- Experience from the original InCubed and InCubed+ shows that activities costs range in scale from hundreds k€ to many M€, with most activities in the range 0.5-5 M€

The key InCubed-2 deliverables are:
- A new Open Call for InCubed Proposals and Invest Actions aimed to develop a multi-pillar framework of partnerships and collaborations with external entities capable to strengthen the InCubed offer
Under the guidance of the European Commission, ESA has provided a comprehensive **CCM Procurement Approach** in discussion with the Commission.

Within this CCM procurement context, the Commission has requested ESA to follow a **Dynamic Purchasing System (DPS)** method.

ESA is currently implementing a **DPS tool within the ESA ‘esa-star’ on-line** procurement system, along the ESA procurement regulations.

The first procurement using the DPS method will start at mid-October 2022 and will be dedicated to **European emerging data suppliers** (i.e. European New Space companies).
**TRUTHS – Mission Objectives**

An operational climate mission, providing:

- **Climate benchmarking**: enhance by an order-of-magnitude our ability to estimate the Earth Radiation Budget through direct measurements of incoming & outgoing energy,

- **Satellites cross-calibration**: establish a ‘metrology laboratory in space’ to create a fiducial reference data set to cross-calibrate other sensors and improve the quality of their data (essential for New Space constellations)

- Provide **SI-traceable measurements** of the solar spectrum to address direct science questions.

**Mission/System Drivers:**

- Climate application drives the stringent Radiometric accuracy (0.3% G÷1% T) ➔ Payload & calibration System design

- Cross-calibration application leads to a non-SSO orbit ➔ Satellite design (CRISTAL P/F recurrent) and dedicated LV (TBC) plus ops.

- Solar/Earth samples in a large spectral range: UV to SWIR (320-2400 nm). SSD 50-100 m, 100 km swath
TRUTHS now and at CM22

- **Platform**, recurrent from CRISTAL, polar non-SSO at 609 km.
- **Satellite**, ~1200kg / 1kW, compatible with Vega-C.
- **Payload**, ~400kg, composed of three elements:
  - **HIS** (Hyperspectral Imaging Spectrometer) – based on a single passively cooled detector operating from UV to SWIR
  - **CSAR** (Cryogenic Solar Absolute Radiometer) – operated at 60 K with cryo-cooler, delivering the “absolute radiometric reference”
  - **OBCS** (On-Board Calibration System) – traceable set of absolute wavelength anchors transferring the CSAR solar absolute measurement to the HIS
- Pre-developments running for all critical items (detector, coating, CSAR, mirror, calibration sources…) with intense interactions with MAG to optimize operational benefit and development risks.
- Phase A completed and phase B1 running at full speed
- At CM22: critical new steps to reach operations in 2030 = Phase B2 + Phase C0 for instrument (engineering model).
Digital Twin Earth (DTE)

Dynamic and interactive representations of processes in the Earth System

Systematically integrating diverse EO data sets

Providing easy access to data, processing & analysis resources and interactive platform functions

Utilising Cloud-, HPC- AI-technologies

Creating new insights through interdisciplinary research based on simulations & predictive modelling

**ESA Digital Twins**

- DT Polar
- DT Hydrology
- DT Oceans
- DT Carbon
- DT Solid Earth

Derived from DTE precursor activities & defined/developed with the scientific community optimised to utilise ESA EO data assets

**DTE Platform Component**

- Integrating and linking Digital Twins
- Enabling visualisation/simulation/modelling functions without coding

**DTE EO Data Space**

- Full cloudification of ESA Earth Explorer-, Heritage- and relevant TPM-data
- Scalable data management for seamless ingestion into Digital Twins Interface optimisation for integrating other data sets (incl. Copernicus data)
Digital Twin Earth (DTE)

**Application Domains:**
- Societal Challenges
- Open Science and Innovation
- Integration of national initiatives
- Contribution to European initiatives
- Step towards a unified ESA Space Data

**DTE Objectives:**
- Provide industrial IT services (i.e. Software as a Service, etc.) for an immersive environment of data exploitation
- Assure scalable system for users to develop: processing-, prototyping-, documentation-, release- workflows
- Commit to the principles of data completeness, timeliness, authenticity, quality, etc. (meet the GAFA challenge)
- Build on a multitude of ESA precursor activities & Member State initiatives
- Serve as basis for possible evolution into DTE&U MDA proposal for 2025
- Feedback into Phase 2 of DestinE
Heritage Space – Overview

• **ESA-wide coordinated action covering 150+ heritage missions/campaigns** from mid 70’s including ERS, Envisat, GOCE, Rosetta, Planck *(one of the largest space data archives in the world)*

• Complementing & supporting other ESA programmes by **ensuring preservation, access, curation and exploitation of ESA heritage space data and information assets** (continuously growing)

• **Partners:** EOP, SCI, HRE, OPS, DG Cabinet

Inter-directorate joint activities

→ ESA-wide **joint innovative concepts & solutions**

→ Removing barriers and avoiding silos mentality

Directorates specific activities

→ Addressing specific needs and filling gaps wrt common strategy and standards

Overarching goal: make ESA heritage data and information more easily accessible to more users, and generate more science and applications out of them
Earthnet – Overview

ESA Earthnet and EU Copernicus Contributing Missions
⇒ An excellent synergy

Earthnet paves the way towards the utilization of commercial data for operational services

R&D, Sciences

Third Party Missions

Data assessment

Operations, Public needs

Copernicus Contributing Missions

Operational delivery
Long-term view – CM22 is only the next stop
CM cycle – Deliverables at different timescales
Accelerator-1: Space for a Green Future

+ Quantum missions for climate
+ Digital Twin Earth
+ Green transition information factories

+ Accelerating decarbonisation & sustainability
= Supporting the climate neutrality by 2050 objective
Accelerator-2: Rapid and Resilient Crisis Response

Linking all key information
Earth Observation
HAPS
In-situ

Into one integrated smart network

User-ready integrated information
Growing EO Up- and Downstream Market Value

European EO Upstream Market Value 2011-2020

- **Telecommunications systems**
- **Earth Observation systems**
- **Navigation systems**

**European EO Up & Downstream**

**Market Value 2021**

- **713 Companies**
  - up from 572 [+24%*]
- **11,600 Employees**
  - up from 9,800 [+17%*]
- **€1.71b Revenues**
  - up from €1.36b [24%*]

**CAGR**

10% sustained

Source: Eurospace, Facts and Figures, 2021

Source: EARSC - European EO Industry (2020 study done 2021)

* Year on year  ** Over 5 years

** The European Space Agency
TO CONCLUDE

EOP at CM22 = 3 B€
≈ 2 euro/year/citizen

- Rol EO programmes > x4 (x8…)
- CAGR of application sector > 10%
## BE Subscriptions Overview *(relative GNP = 2.8%)*

<table>
<thead>
<tr>
<th>Programme</th>
<th>Economic Conditions</th>
<th>Total Subscribed Envelope (M€)</th>
<th>Belgium's Contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EOEP 1-2-3</td>
<td>1997</td>
<td>2,619</td>
<td>55.1</td>
</tr>
<tr>
<td>FUTURE-EO</td>
<td>2012</td>
<td>2,648</td>
<td>59.5</td>
</tr>
<tr>
<td>GSC 1-2</td>
<td>2006</td>
<td>1,553</td>
<td>20.8</td>
</tr>
<tr>
<td>GSC-3</td>
<td>2012</td>
<td>405</td>
<td>2.6</td>
</tr>
<tr>
<td>CSC-4</td>
<td>2019</td>
<td>1,811</td>
<td>48.5</td>
</tr>
<tr>
<td>MTG</td>
<td>2008</td>
<td>1,182</td>
<td>28.7</td>
</tr>
<tr>
<td>METOP SG</td>
<td>2012</td>
<td>809</td>
<td>21.5</td>
</tr>
<tr>
<td>EW GSE</td>
<td>2017</td>
<td>135</td>
<td>13.0</td>
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<tr>
<td>EW CCI</td>
<td>2009</td>
<td>166</td>
<td>9.6</td>
</tr>
<tr>
<td>EW PROBA-V</td>
<td>2012</td>
<td>43</td>
<td>42.8</td>
</tr>
<tr>
<td>EW INCUBED+</td>
<td>2019</td>
<td>64</td>
<td>5.5</td>
</tr>
<tr>
<td>EW ALTIUS</td>
<td>2016</td>
<td>152</td>
<td>142.1</td>
</tr>
<tr>
<td>EW GDA</td>
<td>2019</td>
<td>28</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>11,615</strong></td>
<td><strong>451.1</strong></td>
</tr>
</tbody>
</table>
### Actual Geo-Return statistics BE (status 2021-Q4)

<table>
<thead>
<tr>
<th>Programme</th>
<th>Weighted Amounts (M€)</th>
<th>Return Coefficient (%)</th>
<th>Surplus / Deficit (M€)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EOP DOMAIN</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>prelim. status 2021-Q4</td>
<td>188.3</td>
<td>1.02</td>
<td>4.0</td>
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<tr>
<td>FUTURE-EO</td>
<td>40.2</td>
<td>1.21</td>
<td>7.0</td>
</tr>
<tr>
<td>GSC-3 (1)</td>
<td>2.7</td>
<td>0.96</td>
<td>-0.1</td>
</tr>
<tr>
<td>CSC-4 (2)</td>
<td>16.3</td>
<td>1.11</td>
<td>1.7</td>
</tr>
<tr>
<td>METOP SG</td>
<td>20.4</td>
<td>1.00</td>
<td>-0.1</td>
</tr>
<tr>
<td>EW INCUBED+</td>
<td>4.7</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>EW ALTIUS</td>
<td>75.8</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>EW GDA</td>
<td>0.2</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>EOEP 1-2-3</td>
<td>5.9</td>
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<td>4.0</td>
</tr>
<tr>
<td>MTG</td>
<td>6.6</td>
<td>0.73</td>
<td>-2.4</td>
</tr>
<tr>
<td>EW CCI</td>
<td>1.3</td>
<td>0.62</td>
<td>-1.1</td>
</tr>
<tr>
<td>EW PROBA-V</td>
<td>13.6</td>
<td>0.73</td>
<td>-4.9</td>
</tr>
</tbody>
</table>

(1) GSC-3 statistics excluding compensation measures.
(2) CSC-4 current statistics cover only committed Ph.B2-Adv.C/D activities.
What do CM22 EO programmes buy?
8 new satellites (and much more)

Earth Explorer 10
1 HARMONY

2 MAGIC/NGGM

Small Missions
3 SCOUTS 3-4

Copernicus
5 Sent-1 NG
6 Sent-3 NG (+ recurrent)

TRUTHS
7 Phase B2/C0

Aeolus-2
8 (+ recurrent)

Prepare future Missions
Sent-2 NG and 3-opt NG, M4G, EE-11, -12 and -13, and more (long-term)

Support Commercial EO sector

Deliver activable Earth Science, Essential Climate variables, DTE, …