

The European Space Agency - Earth Observation Programs

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ESA Frequency Management Office

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We Are ESA

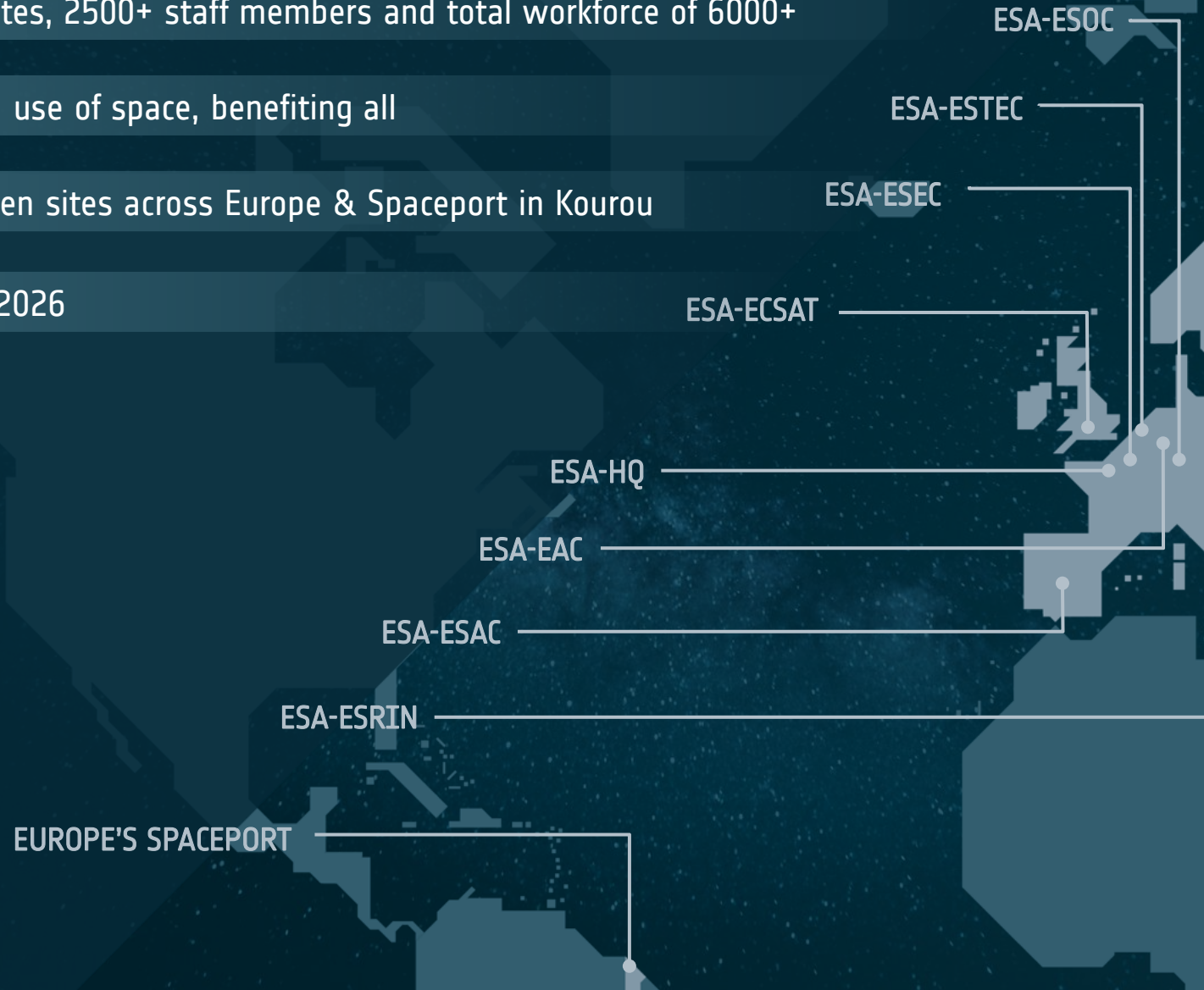


WHO 23 Member States, 2500+ staff members and total workforce of 6000+

WHY For the peaceful use of space, benefiting all

WHERE HQ in Paris, seven sites across Europe & Spaceport in Kourou

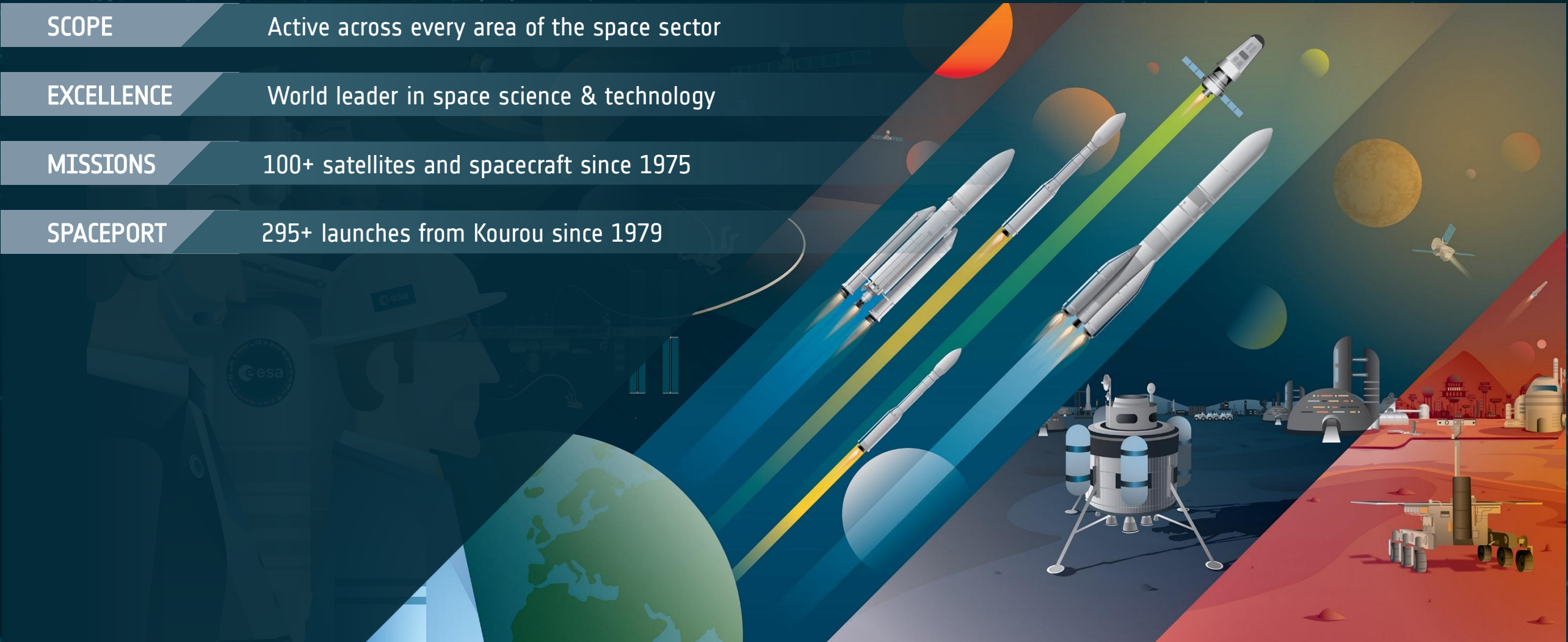
BUDGET €8.26 billion in 2026



What Does ESA Do?



SCOPE	Active across every area of the space sector
EXCELLENCE	World leader in space science & technology
MISSIONS	100+ satellites and spacecraft since 1975
SPACEPORT	295+ launches from Kourou since 1979

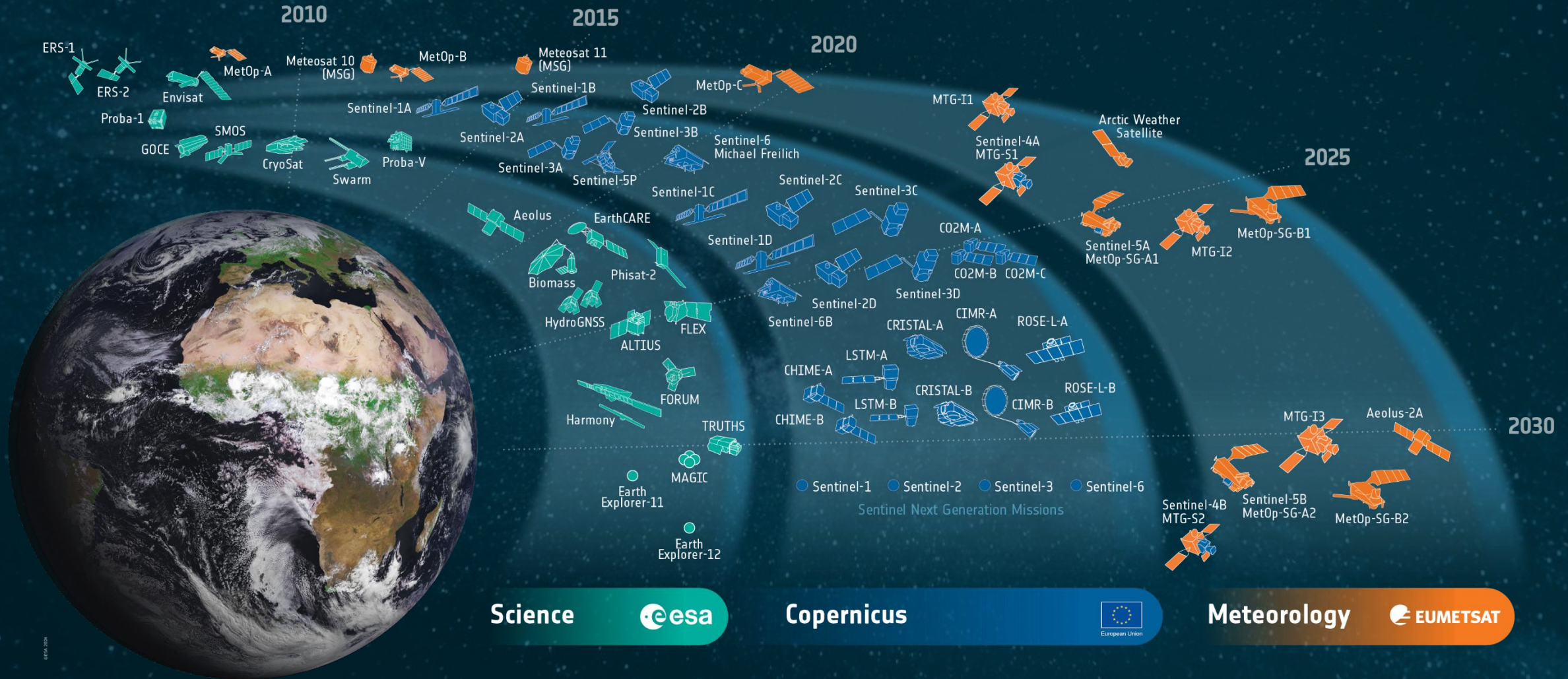


applications

EARTH OBSERVATION

Understanding Earth, improving
lives, and fostering sustainability
through space technology

ESA-developed Earth observation missions



Science



Copernicus

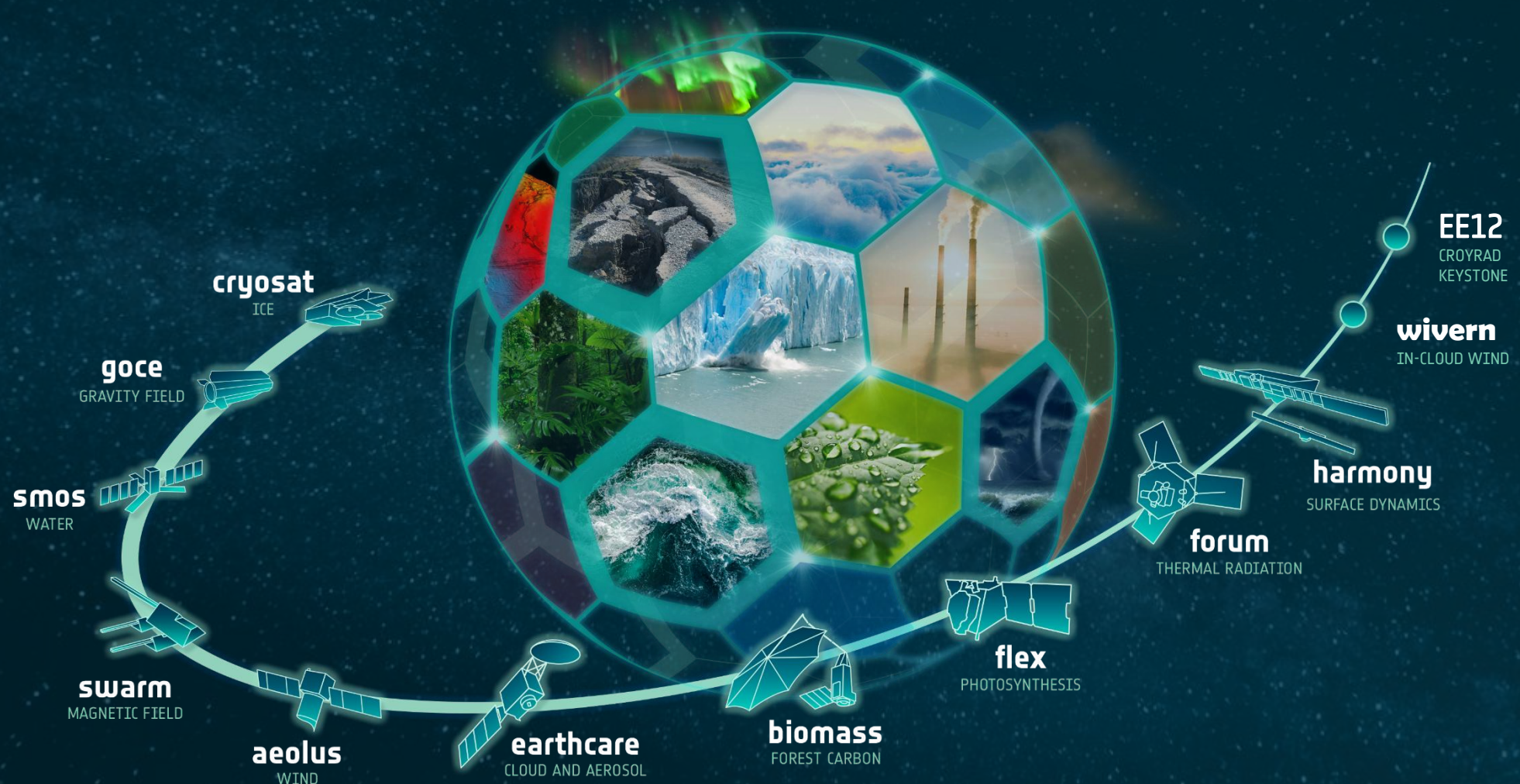


Meteorology



ESA-developed Earth observation missions

Earth Explorers are ESA-developed satellites that use cutting-edge technologies to help maintain European scientific and technological leadership. They are part of FutureEO, ESA's Earth observation research and development programme.



Earth Explorers:

- **GOCE** (2009–2013) studying Earth's gravity field
- **SMOS** (2009–) studying Earth's water cycle (passive 1.4 GHz)
- **CryoSat-2** (2010–) studying Earth's ice cover (altimeter radar 13.5 GHz)
- **Swarm** (2013–) three satellites studying Earth's magnetic field
- **Aeolus** (2018-2023) studying global winds
- **EarthCARE** (2024-) studying Earth's clouds, aerosols and radiation (ESA/JAXA) (radar 94 GHz)
- **Biomass** (2025-) studying Earth's carbon cycle (SAR 435 MHz).
- **FLEX** (2026-) studying photosynthesis
- **FORUM** (2028) measuring Earth's radiation budget in the infrared
- **Harmony** (2029) observing dynamics of oceans, glaciers, volcanoes and earthquakes (SAR passive 5.4 GHz)
- **Wivern** (~ 2032) studying in-cloud winds and the precipitation system (SAR 94 GHz)

Complementary missions:

- **PROBA-V** (2013-) studying the vegetation coverage
- **ALTIUS** (2028) determining the profile of the ozone layer



New family of small satellites within the ESA FutureEO Programme, following the New Space concept while delivering value-added science, either by miniaturising existing space technologies or by demonstrating new observing techniques.

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- A vertical collage of six nature-related images. From top to bottom: 1. A view of Earth from space, showing the curvature of the planet, blue oceans, and white clouds. 2. A bright blue sky filled with fluffy white clouds. 3. A dense green forest with tall trees and sunlight filtering through the leaves. 4. A large, jagged ice formation or glacier in a snowy landscape. 5. A volcanic eruption with bright orange and red lava flowing from a dark, rocky vent. 6. A large, powerful waterfall cascading over a rocky ledge into a pool of water below.

Six Copernicus Sentinel missions are being operated and further developed to address EU policy requirements such as the European Green Deal.

- **Sentinel-1** : land and ocean services; Sentinel-1A launched in 2014, Sentinel-1B in 2016, Sentinel-1C in 2024. (SAR at 5.4 GHz)
- **Sentinel-2** : land monitoring; Sentinel-2A launched in 2015, Sentinel-2B in 2017, Sentinel-2C in 2024.
- **Sentinel-3** : ocean forecasting, environmental and climate monitoring; Sentinel-3A launched in 2016, Sentinel-3B in 2018, Sentinel-3C in 2026. (Altimeter at 5.41 and 13.575 GHz, passive sensors at 23.8 and 36.5 GHz)
- **Sentinel-4, 5** : atmospheric monitoring payloads on-board EUMETSAT satellites MTG and MetOp-SG.
- **Sentinel-5 Precursor** (2017-) : atmospheric monitoring.
- **Sentinel-6** (2020-) : oceanographic and climate studies; operated by EUMETSAT.
- **Sentinel-NG**: Continuation and enhancement of current programme, e.g increasing resolution and extension of observations to the polar region; currently in Phase B2



Additional six missions are under current development to extend the Copernicus Programme.

- **CO2M** (2027) : measuring the CO₂ emissions produced by human activity (2+1 Satellites)
- **CRISTAL** (2027) : measuring the thickness of the ice layers (2 satellites). (Altimeter at 13.5 GHz and 35.75 GHz, passive sensors at 18.7, 23.8, 34, 90, 130 and 168 GHz).
- **LSTM** (2028) : measuring Earth's surface temperatures (2 satellites)
- **CHIME** (2028) : mapping of the Earth's land cover (2 satellites)
- **CIMR** (2030) : measuring sea surface temperatures, the concentration of floating sea ice and sea-surface salinity (2+1 Satellites). (Multi-frequency passive sensors at 1.4, 6.875, 10.65, 18.7 and 36.5 GHz)
- **ROSE-L** (2029) : measuring the vegetation, snow and ice melt for climate change research. (SAR at 1.2575 GHz)



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The top image shows two satellites in space. The larger satellite on the left has two large, rectangular solar panels extended outwards. The smaller satellite on the right also has solar panels. Both are set against a black background filled with stars. The bottom image shows two satellites in orbit around Earth. A blue line traces the orbital path around the planet. The Earth's surface, with its clouds and continents, is clearly visible. The satellites have gold-colored bodies and solar panels.

A satellite in orbit around Earth, showing the planet's curvature and cloud cover. The satellite is positioned on the right side of the frame, with its solar panels and instruments visible. A blue line represents the satellite's orbital path around the globe. The Earth's surface shows a mix of green landmasses, blue oceans, and white cloud formations. The background is the deep black of space, dotted with stars.

- **Meteosat Second Generation** (2002–) : series of 4 geostationary satellites providing images of Earth.
- **Meteosat Third Generation** (2022–) : series of 6 geostationary satellites providing images and atmospheric sounding.

- **MetOp** (2006–) : series of 3 satellites providing operational meteorological observations from polar orbit.
- **MetOp Second Generation** (2025-) : series of 6 polar-orbiters, continuing an enhancing meteorological, oceanographic and climate monitoring observations.
- **AWS PFM** (2024–) : Arctic Weather Satellite as ESA's prototype satellite for the future EUMETSAT constellation **EPS-STERNA**;
To optimise climate predictions for the Arctic by global microwave soundings (multi-frequency passive sensors) of the atmosphere to retrieve e.g. atmospheric temperature and humidity.

Prepared by: EOP-FMT
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All ESA Earth observation missions are using the S-band for TT&C:

- **Telecommand** – 2025-2110 MHz; bandwidths between 300 kHz to 1.2 MHz / satellite.
- **Telemetry** – 2200-2290 MHz; bandwidths between 600 kHz to 6 MHz / satellite.

Effective coordination of S-band frequencies is increasingly important!

- SFCG Resolutions (applicable for space agencies): guidelines for the usage of the S-band
- Recommendations ITU-R SA.2155 (2200 – 2290 MHz) and ITU-R SA.2156 (2025 – 2110 MHz) to use operational bandwidths of no more than:
 - Earth-to-space (2025 – 2110 MHz): ≤ 2.0 MHz
 - space-to-Earth (2200 – 2290 MHz): ≤ 6.2 MHz
 - space-to-space (2025 – 2110 MHz, 2200 – 2290 MHz): ≤ 6.2 MHz

Technological developments towards a potential future migration of TT&C to X-band (7190-7250 / 8025-8400 MHz) or even to Ka-band (22.55-23.15 GHz (preliminary WRC-31 agenda item 2.10) / 25.5 – 27 GHz).

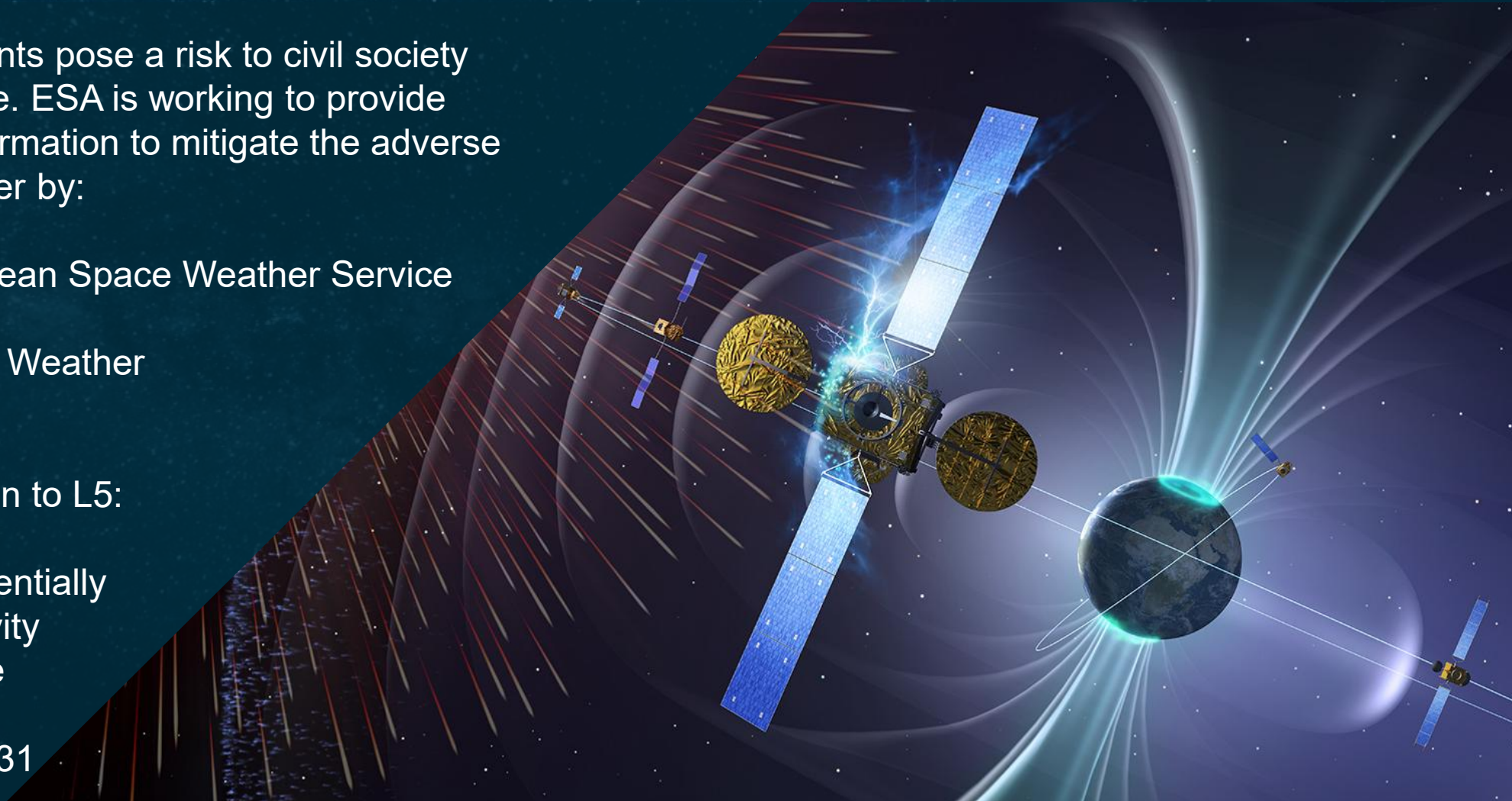
Earth observation missions:

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- The chart displays the projected number of satellites in two frequency bands, X-band and Ka-band, from 2022 to 2031. The X-band (orange line with diamond markers) starts at 12.0 in 2022, dips to 11.0 in 2023, then rises to 14.0 by 2025, remains at 14.0 in 2026, dips to 13.0 in 2027, rises to 15.0 in 2028, dips to 14.0 in 2029, rises to 15.0 in 2030, and ends at 16.0 in 2031. The Ka-band (grey line with triangle markers) starts at 0.0 in 2022, remains at 0.0 until 2025, rises to 1.0 in 2026, 2.0 in 2027, remains at 2.0 in 2028, rises to 5.0 in 2029, 6.0 in 2030, and ends at 8.0 in 2031.
- | YEAR | X-band | Ka-band |
|------|--------|---------|
| 2022 | 12.0 | 0.0 |
| 2023 | 11.0 | 0.0 |
| 2024 | 13.0 | 0.0 |
| 2025 | 14.0 | 0.0 |
| 2026 | 14.0 | 1.0 |
| 2027 | 13.0 | 2.0 |
| 2028 | 15.0 | 2.0 |
| 2029 | 14.0 | 5.0 |
| 2030 | 15.0 | 6.0 |
| 2031 | 16.0 | 8.0 |

SPACE SAFETY

Building resilience for
a sustainable future

- ◆ enhancing our European Space Weather Service Network, and
- ◆ upgrading our Space Weather Coordination Centre

- nts pose a risk to civil society
e. ESA is working to provide
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- ean Space Weather Service
- Weather
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