

# EARTH EXPLORER MISSIONS



As we are challenged by cutting-edge scientific questions, ESA's Earth Explorer satellites pioneer new space technology and observe our planet to reveal crucial information about Earth's system.

Earth is a dynamic, interactive system that involves significant natural variability. Human activity is leaving its mark on these natural processes and changing the interactions in Earth's system. Understanding Earth's changing system is also essential as we tackle the scientific challenges of climate change.

The main purpose of **Earth Explorer missions is to advance Earth science by providing answers to key scientific questions**. This family of research missions provide essential information about Earth's interior, cryosphere, hydrosphere, atmosphere, ionosphere and land surface. Using innovative space technology, they support the quest to understand Earth as a system and the complex interactions within it.

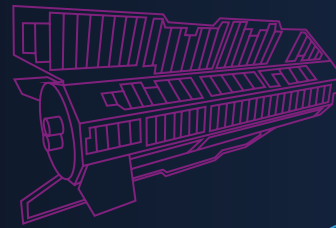


The first Earth Explorer, **GOCE**, which completed its mission in 2013, mapped, in unprecedented detail, variations in Earth's gravity.

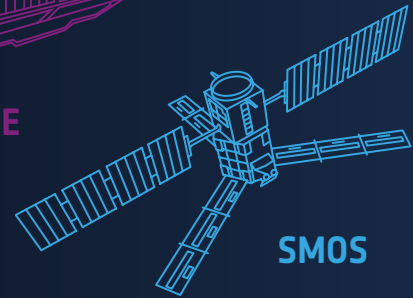
The four missions currently in operation are **SMOS**, **CryoSat**, **Swarm** and **Aeolus**. These satellites provide key measurements about soil moisture and ocean salinity, variations in Earth's cryosphere, the magnetic field and atmospheric circulation.

The next Earth Explorers leverage pioneering space technology to expand further our knowledge on Earth's system. **EarthCARE** will advance our understanding of the role that clouds and aerosols play in reflecting and trapping Earth's radiation, while **Biomass** will measure global forest carbon to increase knowledge about the role of forests in the carbon cycle. The **FLEX** mission will provide information about photosynthetic activity, to shed light on the functioning of Earth's vegetation.

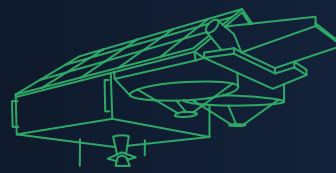
As part of ESA's continuing commitment to advance our scientific understanding of Earth, this family of extraordinary satellite missions will continue to grow as candidate mission concepts are selected to be developed and built.



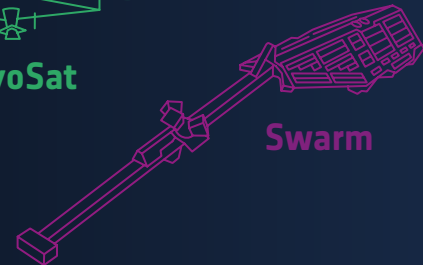
**GOCE**



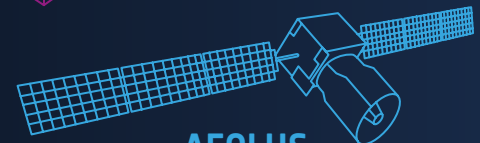
**SMOS**



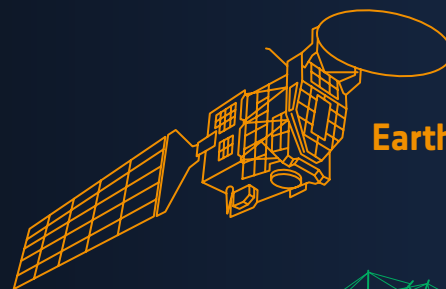
**CryoSat**



**Swarm**



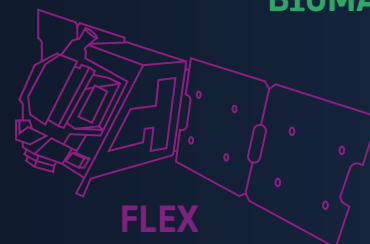
**AEOLUS**



**EarthCARE**



**BIOMASS**



**FLEX**

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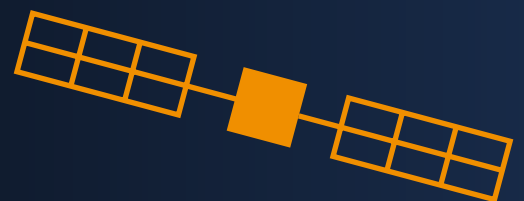
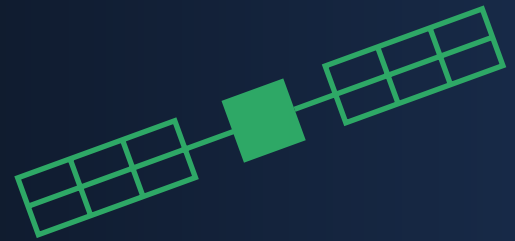
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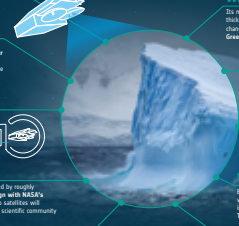


# LEARN MORE ABOUT OUR MISSIONS

These infographics provide an introduction to the four Earth Explorer missions currently in operation: CryoSat, SMOS, Aeolus and Swarm.

They highlight the different capabilities of the missions and their many achievements.

### CryoSat in Brief



**What?** CryoSat is ESA's third Earth Explorer satellite and Europe's first ice mission.

**Revolutionary** CryoSat carries the first spaceborne synthetic aperture interferometric radar altimeter (SRAL), a sensor optimized to study sea-ice floes as they drift in the ocean and rugged glaciers.

**10 Years in Space** In 2010, CryoSat celebrated a decade in space, during which it has met and surpassed its mission objectives with data being used daily in innovative ways.

**In Resonance** In July 2020, CryoSat's orbit was raised by roughly 300 metres so it would periodically align with NASA's ICESat-2. The data collected by the two satellites will unlock a wealth of new benefits for the scientific community.

**Data and Users** Serving around 1000 registered users from over 70 countries, it generates approximately 1 TB of raw data/month and 100 GB of ocean data/month. Access to data is free and open.

**Which?** Its main objectives are to measure thickness of polar sea ice and monitor changes in ice sheets that threaten Greenland and Antarctica.

**When?** Launched on 8 April 2010, on a Russian-Frenchian Dnepr Rocket, with a mean Sun-synchronous low Earth Orbit at 725 km mean altitude, CryoSat orbits the latitudes of 68° North and South.


**Why?** Developed to meet the needs of the ice research community, it aims to provide a precise picture of how Polar Regions are responding to global warming.

**Where?** Built by Airbus in Germany, with its SRAL radar altimeter developed by Thales Alenia Space, France.

**Data Access** <https://science-pds.cryoat.esa.int>

**For more information visit:** <https://earth.esa.int/cogateway/missions/cryoat>

### About SMOS



**What?** SMOS (Soil Moisture and Ocean Salinity) is one of ESA's Earth Explorers dedicated to capturing brightness temperature images of Earth's surface.

**Innovative** SMOS carries the first spaceborne microwave interferometric radiometer (MIRAS) to measure Earth's surface radiation at 1.4 GHz.

**When?** Launched 2 November 2009, initially designed for a three-year mission, it's still delivering key information to advance science and data used in various practical applications, such as weather forecasting.

**What's next?** Going way beyond its original scientific aim of delivering critical information to understand Earth's water cycle, SMOS continues to demonstrate its suitability for new uses. Some examples include:
 

- providing information to measure the sea floating ice in the polar seas accurately enough for forecasting and ship routing
- measurements of severe winds over oceans to support tropical cyclone monitoring and forecasting
- measuring the solar flux to support space weather applications and solar science studies

**Where?** The PROTEUS spacecraft platform SMOS uses was designed and built by CNES and Alcatel Alenia Space, while the MIRAS instrument was designed and built by a consortium of 20 European companies, led by ESA's ESA-ESRAC (now ESA).


**Applications?** It is the first mission to provide global observations of the temporal and spatial variability in soil moisture and sea surface salinity, which are driven by the continuous exchange in Earth's water cycle between the oceans, atmosphere and land.

**Benefits?** These key geophysical parameters—soil moisture for understanding hydro-meteorological processes and salinity for understanding ocean circulation—are both vital for climate change studies. Its images are used to derive global maps of soil moisture and sea surface salinity every three days, at a spatial resolution of about 50 km.

**Data and Users** Since the beginning of the SMOS mission, around 24.2 million products have been downloaded from ESA's SMOS dissemination service, by more than 2700 active users, for a total volume of 500 TB of data.

**Data Access** <https://amos-dss.esa.int/feeds/access>

### Aeolus in Brief



**What?** Aeolus is ESA's youngest Earth Explorer and the first satellite mission to observe profiles of Earth's winds, on a global scale and vertical distribution of aerosols and clouds.

**Why?** Aeolus's near-real time observations improve the accuracy of numerical weather prediction and advance our understanding of atmospheric phenomena and processes, relevant to climate variability.

**A helping hand** During the COVID-19 pandemic, Aeolus measurements proved crucial to fill the gap in weather observations caused by the grounding of commercial airplane fleets.

**Tropical success** Aeolus data have made a big difference to weather prediction over parts of the world where there is a lack of other wind observations, such as tropical regions.

**Assimilation** Four of Europe's biggest meteorological services have already assimilated Aeolus data into their forecasts: the European Centre for Medium-Range Weather Forecasts, Germany's Deutscher Wetterdienst, Météo-France and the UK's Meteorological Office.

**Beyond weather prediction** Aeolus data have proven their value optimization in air quality and climate related studies, when they helped scientists track smog over wildfires in the atmosphere and investigate the Quasi-Biennial Oscillation over the tropical belt.

**When?** It was launched on a Vega rocket on 22 August 2018, from Europe's Spaceport in France, French Guiana. It orbits at an altitude of 320 km.

**Where?** It was built by Airbus in Stevenage, UK, with the ALACEO instrument developed by Airbus engineers in Bordeaux, France and its laser transmitter by Leonardo SPA in Florence and Pinerole, Italy.


**Innovation** The satellite carries the unique Atmospheric Laser Doppler Interferometer (ALADI), the first Doppler wind lidar in space.

**Public release** Aeolus data were made public in May 2020, and are now being distributed in near real-time through ESA's Aeolus Online Dissemination Centre as well as EUMETSAT and WMO's Global Telecommunication System (GTS).

**Data Access** <https://earth.esa.int/cogateway/missions/aeolus>

**For more information visit:** <https://earth.esa.int/cogateway/missions/aeolus>

### Swarm in Brief



**What?** Swarm is ESA's magnetic field mission and the first Earth Explorer constellation made up of three identical satellites: Alpha, Bravo and Charlie. Their main objective is to measure the magnetic signals that come from Earth's core, mantle, crust, oceans, ionosphere and magnetosphere.

**Why?** Swarm data are fuelling studies into Earth's weakening and drifting magnetic shield, the structure of Earth's interior, space weather and radiation hazards.

**Milestones** Swarm was designed to operate for 4 years, following a three-month commissioning phase, but has already been in operation for double its initially projected lifetime. In 2022, it will celebrate 8 years in orbit.

**4th Satellite** In March 2020, the Canadian Space Agency's e-POP payload, aboard the CASISOP satellite, was integrated into the Swarm constellation as the fourth member (Swarm-Delta) under ESA's Earthnet Third Party Mission Programme.

**Innovation** Each of the Swarm satellites carry five scientific instruments: a Vector Field Magnetometer (VFM), an Absolute Scalar Magnetometer (ASM), an Electric Field Instrument (EFI), Accelerometers (ACC) and a Laser Range Finder (LRF). Swarm's vector field sensors are the first 3D-magnetometer of their kind in orbit.

**Data and Users** Swarm generates approximately 120 GB data/month. An estimated 13 TB of data have been generated during the Swarm constellation's eight 8 years in orbit. Swarm serves over 1000 registered users from 70 countries.

**Data Access** <https://swarm-dss.esa.int>

**For more information visit:** <https://earth.esa.int/cogateway/missions/swarm>

# LEARN MORE ABOUT EARTH EXPLORERS

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