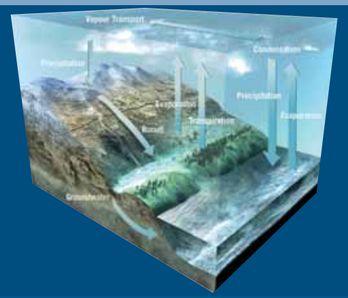
SMOS

ESA's water mission

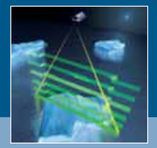
- **Science:** Variability of the moisture in soil and salinity in the oceans is a consequence of the continuous exchange of water between the oceans, the atmosphere and the land - the Earth's water cycle. However, despite the water cycle being one of the most important processes operating on the planet - sustaining life and controlling our climate - this fundamental system is still relatively poorly understood.

- **Mission:** SMOS (Soil Moisture and Ocean Salinity) mission will carry a sophisticated interferometric radiometer capable of observing both soil moisture and ocean salinity by capturing images of emitted microwave radiation at 1.4 GHz (L-band). These data are urgently needed to understand more about the Earth's finite water resources, as well as advance weather and climate prediction. In particular, soil moisture data will be important for extreme-event forecasting. The objective is to acquire data to produce weekly global soil moisture maps to an accuracy of 4% volumetric soil moisture with a spatial resolution of approximately 25-50 km. Over the open ocean, the goal is to observe salinity down to 0.1 practical salinity units averaged over 10-30 days and an area of 200 x 200 km.

Opportunity mission



CRYOSAT 2

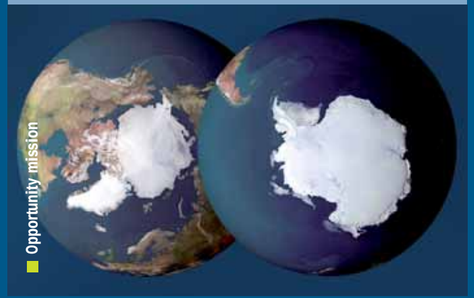


ESA's ice mission

- **Science:** Almost 80% of the Earth's fresh water is locked up in ice and snow. As land and sea ice play a major role in moderating the global climate, the consequences of receding ice cover due to global warming are far reaching and complex. It is important to determine rates of change in the thickness of marine and continental ice cover for predicting future climate and sea level.

- **Mission:** CryoSat-2 will acquire accurate measurements of the thickness of floating sea-ice so that seasonal to inter-annual variations can be detected, and will also survey the surface of continental ice sheets to detect small elevation changes. Cryosat-2's high spatial resolution radar altimeter is capable of operating in a number of modes, optimised for measurement over different surfaces. The mission will determine regional trends in Arctic perennial sea-ice thickness and mass, and determine the contribution that the Antarctic and Greenland ice sheets are making to mean global rise in sea level. CryoSat-2 will also observe the seasonal cycle and inter-annual variability of Arctic and Antarctic sea-ice mass and variation in the thickness of the Earth's ice caps and glaciers.

Opportunity mission



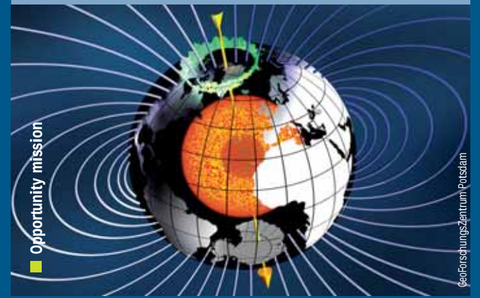
SWARM

ESA's magnetic field mission

- **Science:** The Earth's magnetic field is complicated. Largely, it is produced by electric currents in the outer-core, but measurements taken at or near the surface also include the superposition of fields from magnetised rocks in the crust, electric currents flowing in the ionosphere, magnetosphere and oceans, and currents induced in the Earth by time-varying external fields. There is a need to understand how the different components of the Earth's magnetic field vary in time and space.

- **Mission:** Swarm is a constellation of three satellites that will provide high-precision and high-resolution measurements of the strength and direction of the magnetic field. GPS receivers, an accelerometer and an electric-field instrument will provide supplementary information for studying the interaction of the magnetic field with other physical quantities describing the Earth system. The geomagnetic field models resulting from the Swarm mission will provide new insights into the Earth's interior, further our understanding of atmospheric processes related to climate and weather, and will also have practical applications in many different areas such as space weather and radiation hazards.

Opportunity mission



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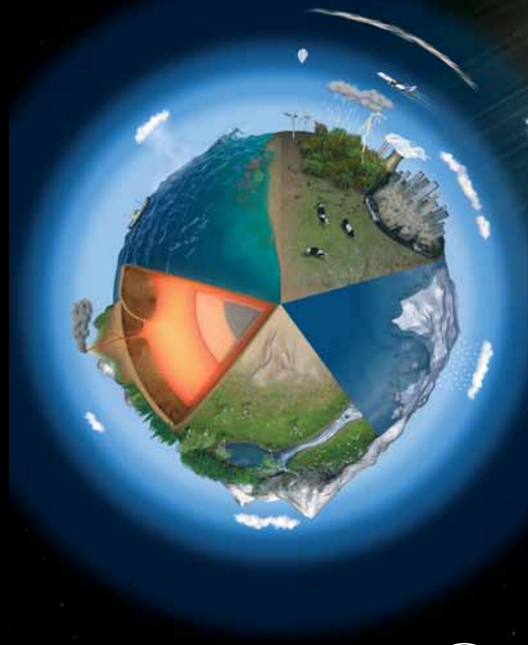
EARTH EXPLORERS



www.esa.int/livingplanet

European Space Agency
Agence spatiale européenne

the Living Planet

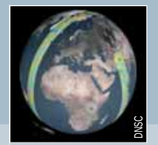
GOCE

ADM-Aeolus

EarthCARE

SMOS

CryoSat-2



Swarm

The Living Planet Programme

Today, the biggest threat to life on Earth is global change, which not only encompasses the consequences of a warming climate, but also the large-scale impact that a growing global population and continued economic growth place on the Earth's resources and environment.

It is crucial that we continue to monitor our planet from space if we are to better understand the Earth system as a whole and develop ever-more sophisticated models to predict future global trends. As our quest for knowledge builds, so does our demand for accurate satellite data to be used for numerous practical applications relating to protecting and securing the environment.

These challenges form the basis of ESA's Living Planet Programme, which comprises two main areas: a science and research component, and the Earth Watch element designed to facilitate the delivery of data for the eventual use in operational services. Earth Watch includes the well-established meteorological missions with EUMETSAT, and also new missions focusing on the environment and civil security under GMES (Global Monitoring for Environment and Security) - a European Commission initiative through which ESA carries the responsibility for implementation of the space component.

Satellites to understand our changing Earth

ESA's fleet of Earth Explorers are the research missions of the Living Planet Programme. These missions focus on the atmosphere, biosphere, hydrosphere, cryosphere and the Earth's interior, with the overall emphasis on providing data to advance our understanding of the interactions between these components and the impact that human activity is having on natural Earth processes.

Earth Explorers are defined, developed and operated in close cooperation with the science community. By involving the science community right from the beginning and introducing a peer-reviewed selection process, missions are developed efficiently and provide the exact data required by the user. This on-going user-driven approach has given the Earth science community an efficient tool to understand and monitor our planet. The science questions addressed also form the basis for the development of new applications for Earth Observation data. So far, this formula has resulted in the selection of these six Earth Explorers with further missions under study.

Gravity Field and Steady-State Ocean Circulation Explorer

Atmospheric Dynamics Mission

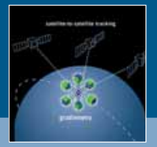
Earth Clouds, Aerosols and Radiation Explorer

Soil Moisture and Ocean Salinity

Monitoring ice thickness

Studying the Earth's magnetic field

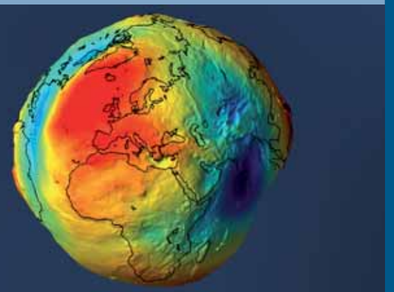
GOCE



ESA's gravity mission

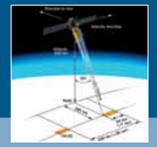
- **Science:** Although invisible, gravity is a fundamental and complex force of nature which, due to a number of factors, varies significantly from place to place on the surface of the planet. A better knowledge of the gravity field is needed to provide more insight into the Earth's interior whilst a precise model of the geoid (a surface of equal gravitational potential defined by the gravity field) is crucial to understanding more about ocean circulation.

- **Mission:** The GOCE (Gravity Field and Steady-State Ocean Circulation Explorer) mission is dedicated to measuring the Earth's gravity field and modelling the geoid with unprecedented accuracy and spatial resolution. By employing a three-axis electrostatic gravity gradiometer that measures gravity gradients in all spatial directions, GOCE will determine gravity field anomalies with an accuracy of 1 mGal (where 1 mGal = 10^{-5} m/s^2), and the geoid with an accuracy of 1-2 cm - both with a spatial resolution of better than 100 km. This mission will advance our knowledge of ocean circulation, which plays a crucial role in energy exchanges around the globe, sea-level change and Earth interior processes. GOCE will also make significant advances in the field of geodesy and surveying.



Core mission

AEOLUS



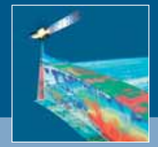
ESA's wind mission

- **Science:** The wind is one of the most important variables that describe the state of the atmosphere. Accurate global observations on wind speed and direction are urgently needed to enhance atmospheric modelling so that operational weather forecasting, as well as the prediction of long-term climate change, can be improved. Observations have to be performed in space if global, independent and direct measurements are to be achieved.

- **Mission:** The Earth Explorer Core Mission ADM-Aeolus (Atmospheric Dynamics Mission) will be the first space mission to measure wind profiles on a global scale. Expected to result in a breakthrough in weather prediction, Aeolus will probe the atmosphere with a highly sophisticated instrument called a 'Doppler wind lidar' with the objective of measuring global wind profiles up to an altitude of 30 km. Wind will be measured to an accuracy of 1 m/s in the planetary boundary layer (up an altitude of 2 km), and 2 m/s in the free troposphere (up to an altitude of 16 km). This mission will improve the accuracy of numerical weather forecasting and advance our understanding of atmospheric dynamics and processes relevant to climate variability and climate modelling.

Core mission

EARTHCARE



ESA's cloud & aerosol mission

- **Science:** The Earth's radiation budget is primarily governed by clouds. They warm the atmosphere by trapping infrared radiation emitted from the surface of the Earth, and keep the atmosphere cool by reflecting incident solar radiation back out into space. Aerosols also contribute to the energy budget through their interaction with radiation and their role in cloud formation. Vertical profiles of clouds and aerosols are currently much-needed to further our understanding of their interactions with radiative processes and to improve climate-change predictions.

- **Mission:** The Earth Explorer Core Mission EarthCARE (Earth Clouds, Aerosols and Radiation Explorer) is being implemented in cooperation with the Japanese Aerospace Exploration Agency (JAXA), and addresses the need for a better understanding of the interactions between cloud, radiative and aerosol processes that play a role in climate regulation. The payload will consist of instruments for measuring cloud and aerosol properties, namely a high spectral resolution atmospheric lidar, a cloud-profiling radar with Doppler measurement capability and a multi-spectral imager. Furthermore, a broadband radiometer will measure top-of-the atmosphere radiances and fluxes.

Core mission