

Swarm: ESA's magnetic field mission

Earth Explorer series continued

Swarm is one of ESA's Earth Explorer missions. Earth Explorers are developed in direct response to issues raised by the scientific community. They aim to improve our understanding of how Earth works as a system and the impact human activity is having on natural Earth processes.

Swarm will be the fourth Earth Explorer mission in orbit, following GOCE, SMOS and CryoSat, launched in March 2009, November 2009, and April 2010 respectively.

This innovative mission sets out to identify and measure precisely the magnetic signals that stem from Earth's core, mantle, crust, oceans, ionosphere and magnetosphere. Swarm will provide data to study the complexities of Earth's protective magnetic shield. This will lead to a better insight into the processes occurring inside the planet and a clearer understanding of the near-Earth electromagnetic environment and the influence solar wind has on Earth.

Understanding how Earth's protective shield is weakening

Earth's magnetic field acts as a shield, protecting the planet from charged particles that stream towards us in solar winds. Without this protective shield, the atmosphere as we know it would not exist, rendering life on Earth virtually impossible. The magnetic field is generated mainly deep inside the planet by a huge ocean of swirling iron that makes up the liquid outer core. Driven by currents churning in the outer core, the electrically charged molten iron acts like a bicycle dynamo, generating our continuously changing electromagnetic field. Other sources of magnetism come from rocks in Earth's crust, electric currents flowing in the ionosphere, magnetosphere and oceans.

This complex force is in a constant state of flux. Magnetic north wanders and every few hundred thousand years the polarity flips so that a compass would point south instead of north. Moreover, the strength of the magnetic field constantly changes – and is currently showing signs of significant weakening.

The first Earth Explorer constellation

The Swarm mission is ESA's first Earth observation constellation of satellites. The three identical satellites will be launched together on one rocket from Russia into a near-polar, low-Earth orbit.

Two will orbit almost side-by-side at the same altitude – initially at about 460 km, descending to around 300 km over the lifetime of the mission. The third satellite will be in a higher orbit of 530 km and at a slightly different inclination. The satellites' orbits drift, resulting in the upper satellite crossing the path of the lower two at an angle of 90° in the third year of operations.

Essentially, the two different orbits, along with the various Swarm instruments, improve the sampling in space and time. This helps to distinguish between the effects of different sources of magnetism.

Heading north

The Swarm mission takes advantage of a new generation of magnetometers. An electric field instrument, an accelerometer and GPS receivers will deliver supplementary information to study the interaction of Earth's magnetic field with solar winds, electric currents and radiation, and their effects on the Earth system.

Designed to unravel the mysteries of the magnetic field, the trio of satellites will provide the data to separate and model the different sources that make up the geomagnetic field. This will lead to greater insight into many natural processes – from those taking place deep inside the planet driving Earth's dynamo to weather in space caused by the Sun's activity, and further our understanding of why magnetic north wanders and, moreover, why the magnetic field is weakening.

Facts and figures

- Launch: April 2013 on a Rockot (with Breeze-KM upper stage) provided by Eurockot Launch Services GmbH
- Launch site: Plesetsk Cosmodrome, Russia
- Mission control: ESA's European Satellite Operations Centre (ESOC) in Darmstadt, Germany, via ESA's ground station in Kiruna in Sweden
- Data: science data downloaded to Kiruna ground station. Data processing, distribution and archiving managed by ESA's Centre for Earth Observation ESRIN in Frascati, Italy
- Satellites: constellation of three identical satellites carrying the same instrument package
- Instruments: Vector Field Magnetometer mounted on an optical bench with the three startrackers, Absolute Scalar Magnetometer (Laser), Electric Field Instrument (Thermal Ion Imager & Langmuir Probe), Accelerometer, GPS receiver (dual frequency), and laser retroreflector
- Satellite configuration: each satellite weighs 468 kg at launch (including 99 kg of Freon propellant) and is 9.1 m long (including a 4-m deployable boom), 1.5 m wide and 0.85 m high
- Power: GaAs solar cells, 48 Ah Li-ion batteries.
- Orbit: near-polar; low Earth; two satellites orbiting almost side-by-side decaying naturally from an initial altitude of 460 km to 300 km over 4 years, while the third orbits at about 530 km
- Mission life: nominally 4 years (plus 3-month commissioning period)
- Prime Contractor: EADS-Astrium GmbH

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