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 Earth in solar winds. Without this shield the atmosphere would be stripped by solar winds, rendering life on Earth 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 also 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 occasionally flips, in which case compasses would point south instead of north, and the field varies in strength. Currently, the magnetic field shows 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 in tandem 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. Over the course of the mission, the orbit of the higher satellite will drift to cross the path of the two lower satellites at an angle of 90°.

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 plant 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: mid-July 2012 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, Sweden and Svalbard, Norway
- 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 star-trackers, 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 500 kg and is 9.1 m long (including a 4 m deployable boom), 1.5 m wide and 0.85 m high
- Power: two wings of GaAs solar cells body mounted, delivering 608 W (beginning of life) and a set of 48 Ah Li-ion batteries.
- Orbit: near-polar; low Earth; two satellites orbiting side-by-side sinking from an initial altitude of 460 km down to 300 km over 4 years while the third orbits at 530 km
- Mission life: nominally 4 years (plus 3-month commissioning period)
- Prime Contractor: EADS-Astrium GmbH

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