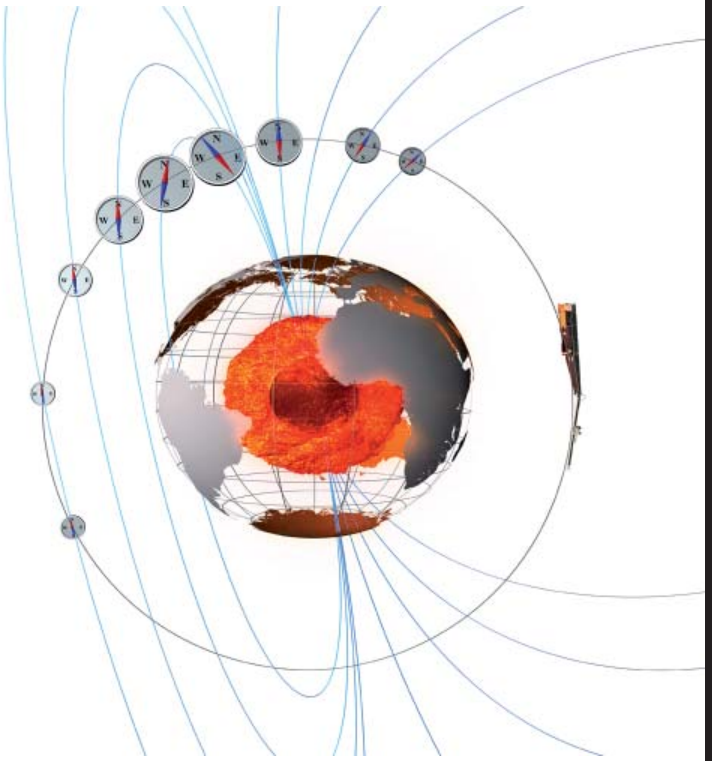
The best ever survey of Earth's magnetic field

In late 2013, a new generation of satellites, the Swarm satellite trio, will be launched to study Earth's magnetic field from space with unprecedented precision and resolution. Swarm is one of the Earth observation missions in ESA's Living Planet programme.

The main objective is the survey of the spatial structure and time changes of Earth's magnetic field. This will drive improvements in our knowledge of both Earth's interior and of near-Earth space.



Swarm is a constellation of three satellites in three different polar orbits between 300 and 530 km of altitude. During their flight, high precision instruments will measure the direction, intensity, and temporal variations of the magnetic field. In combination, these measurements will provide the observations necessary to extract high resolution models of the various sources of Earth's magnetic field.

Objectives

The Swarm mission shall provide greater knowledge of:

- Core dynamics, and the geodynamo process
- Lithospheric magnetization and its interpretation
- 3D electrical conductivity of the mantle
- Currents in the magnetosphere and ionosphere
- Magnetic signature of the ocean
- Magnetic forcing of the upper atmosphere

Facts

Satellites: Constellation of 3 identical satellites, each with dimensions 9.1 m x 1.5 m x 0.5 m and weighing 468 kg
Orbits: Near polar, 2 side by side, at 460 km altitude, descending to 300 km altitude, the third at 530 km altitude
Launch: End of 2013, Rockot rocket from Plesetsk Cosmodrome, about 800 km north of Moscow
Lifetime: Minimum 5 years
Built by: EADS, Astrium
Scientific data analysis: SCARF consortium under the leadership of DTU Space

Instruments:

- Vector field magnetometer mounted on an optical bench with 3 star trackers
- Absolute scalar magnetometer
- Thermal Ion camera and Langmuir probe
- Accelerometer
- GPS receiver
- Laser retroreflector

Contacts at DTU:
N. Olsen, nio@space.dtu.dk
E. Friis-Christensen, efc@space.dtu.dk
P. E. Holmdahl Olsen, poeho@space.dtu.dk
C. Finlay, cfinlay@space.dtu.dk

www.esa.int
www.space.dtu.dk/forskning/projekter/swarm
www.astrium.eads.net

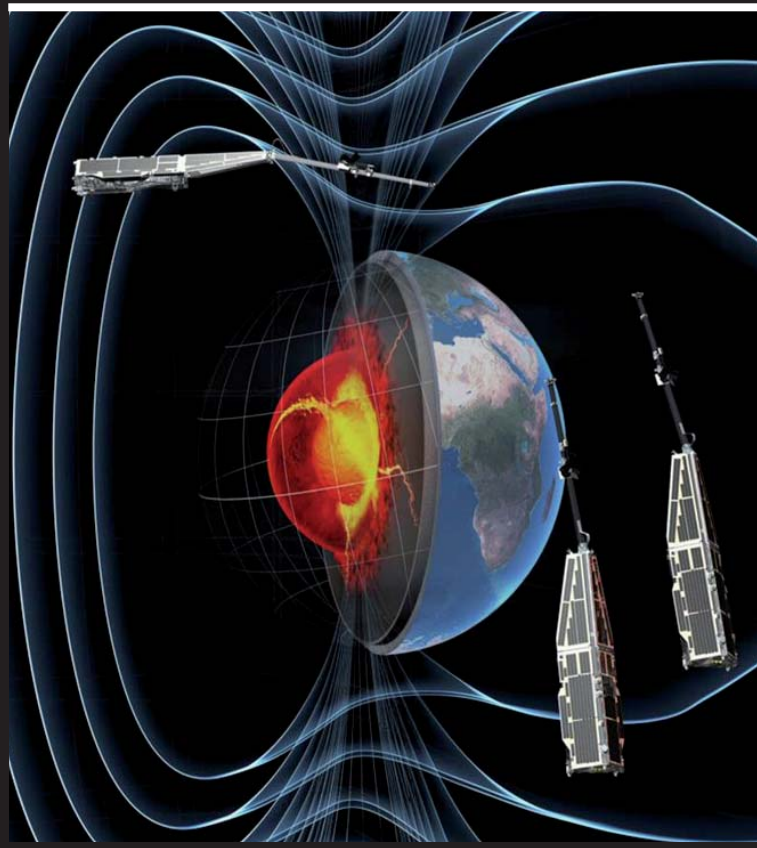
esa

Technical University of Denmark

DTU

Swarm

Satellite Trio on a Voyage through Earth's Magnetic Field



DTU Space
National Space Institute

A historical perspective

Scientific studies of Earth's magnetic field have a long and distinguished history, dating back to the 13th century. In 1820 H.C. Ørsted discovered that electrical currents produce magnetic fields, and in 1839 C.F. Gauss showed that Earth's magnetic field is primarily produced by sources within the planet.

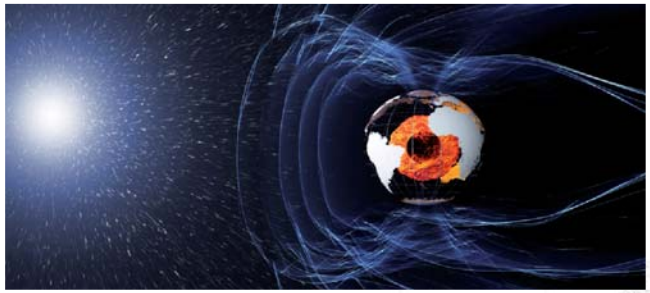
The first detailed mapping of the strength and direction of Earth's magnetic field was made by the NASA satellite Magsat in 1980, but it flew only for 8 months.

In 1999 the Danish Ørsted satellite was launched, carrying an innovative non-magnetic star tracker mounted with the magnetic instrument. The project also clearly highlighted the need to gathering scientific expertise in a single team spanning across traditional disciplines. This was found to be essential because the measured magnetic field originates from a variety of sources, from the inner Earth, the Earth's crust, from the currents in the ionosphere and from currents in the magnetosphere, far outside the trajectory of the satellites.

H.C. ØRSTED, ENGRAVING AFTER EM. BÆRENTZEN

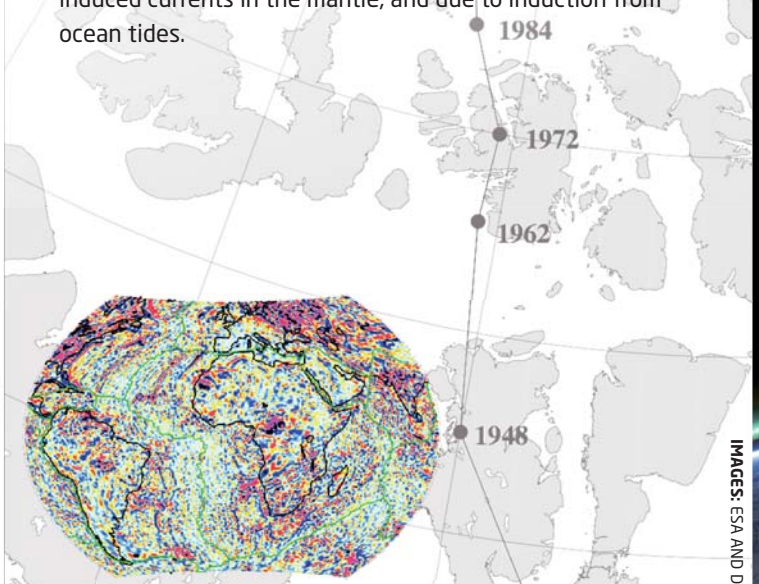
Scientific background

Earth's magnetic field mediates the interactions between our Earth and the wider solar system. It deflects the charged particles of the solar wind around the Earth.



The magnetic field is primarily generated in Earth's outer core, where motions of liquid metal generate electrical currents by motional induction. This core-generated field is not a simple dipole, but has regions of higher and lower intensity, and is constantly changing in time. This is evident from the constant wandering of the magnetic pole.

In addition, there are also smaller magnetic signatures due to the magnetization of rocks close to the Earth's surface, from induced currents in the mantle, and due to induction from ocean tides.



THE MAGNETIC FIELD DUE TO TECTONIC STRUCTURES IN EARTH'S CRUST.

A Danish-led project

The Swarm project was conceived by a team of Danish scientists and engineers, lead by Eigil Friis-Christensen, building on their experience from the successful Ørsted satellite mission launched in 1999.

A joint proposal with colleagues from France and Germany, with the support of 27 scientific institutions worldwide, was selected in 2004 to be the 5th ESA Earth Explorer mission. DTU has a leading role in the consortium of experts that will derive scientific products from the Swarm observations.

Danish payload on the Swarm satellites
The Swarm instrument package includes a tri-axis, vector magnetometer mounted on an optical bench with three start trackers. Both the vector magnetometer and the star trackers were designed and built at DTU.

IMAGES: ESA AND DTU SPACE