



## SWARM – Earth's magnetic field to be accurately measured by three European satellites flying in formation

22 November 2013

On Friday 22 November at 13:02 CET (12:02 GMT) the three European SWARM satellites were lifted into orbit from the Plesetsk Cosmodrome in northern Russia by a Rockot launch vehicle. The mission will take high accuracy measurements of Earth's magnetic field, expanding our knowledge of the processes at work in Earth's interior as well as in near-Earth space. SWARM is the fourth Earth exploration mission in the European Space Agency's 'Living Planet' programme. With a share of about 25 percent, Germany is a leading contributor to the programme. The SWARM project office, funded by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) Space Administration, will coordinate German researchers and data usage to optimise the scientific return.

### Earth 'under attack'

Our planet is constantly being bombarded by energetic particles from the Sun and outer space. Fortunately, Earth's magnetic field protects us from this dangerous radiation. But measurements taken over the last few decades have shown that it is weakening and – as has often happened in the past – is preparing to reverse its polarity. The three identical satellites, all equipped with highly sensitive instruments, were carried into space by a single launcher. Two of them will fly 'side-by-side' in a common orbit at an altitude of 460 kilometres, while the third one will orbit Earth at 530 kilometres. They will circle Earth in formation like a 'swarm' and map the magnetic field in three dimensions with unprecedented accuracy during their four-year mission.

Although Earth's magnetic field has been measured and researched for about 150 years, there are still gaps in our knowledge of it. The German predecessor to the SWARM mission, CHAMP, has already delivered important results and significantly extended our understanding of the magnetic field while simultaneously raising new questions. Despite the protective 'bubble', showers of particles occasionally enter the atmosphere. The consequences of these particle invasions can vary – power grids fail, computer systems produce errors and navigation networks are disrupted. It is clear that complex, elusive processes involving external influences and changes to Earth's magnetic field are still hidden from us. Recently, it has been recognised that the situation is much more complicated than suspected, because every part of the overall system is connected to everything else. Using the data acquired with SWARM, geoscientists now want to determine the exact interrelationships.

### Contribution to climate and environmental research

Thanks to the advanced instruments carried by SWARM, it should be possible to investigate large-scale ocean currents. The movement of electrically conductive salt water contributes to Earth's magnetic field. However, this effect is almost five orders of magnitude smaller than the static magnetic field. SWARM will be able to make an important contribution to climate research, since the dynamics of currents and tides in the oceans significantly affect the climate.

Through continuous observations, the three identical satellites will also support European research activities involving the overall Earth system, climate and environment, and provide important reference data with regard to Earth's magnetic field, its ionosphere and thermosphere, space weather, geodesy and geosciences.

## German contribution to data utilisation

The DLR Space Administration SWARM Project Office, funded by the German Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi) will organise, on the German side, the user community, advise scientists and coordinate research projects. It is also developing usage concepts and carrying out public relations activities. Through its work, the project office is establishing national and international programmes for scientific interpretation of SWARM data, and is available outside the scientific community as an information and contact point for other users. Thus, it will contribute significantly to the scientific output of this 'Explorer' mission.

Currently, preparations are underway to validate the SWARM data, an important contribution to quality assurance. For this work, ESA has appointed an international science team under the leadership of the SWARM Project Office. In Germany, the team comprises the German Research Centre for Geosciences in Potsdam (Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum; GFZ), the Leibniz Institute of Atmospheric Physics (Leibniz-Institut für Atmosphärenphysik; IAP) in Kühlungsborn, Jacobs University (JUB) in Bremen and the Institute for Astronomical and Physical Geodesy (Institut für Astronomische und Physikalische Geodäsie; IAPG) at the Ludwig Maximilian University in Munich.

## Earth system research with 'Living Planet'

SWARM is the fourth mission of the ESA programme 'Living Planet', which provides targeted contributions to important issues of Earth system science using the selected satellite missions. The previous 'Earth Explorer' missions were the Gravity field and steady-state Ocean Circulation Explorer (GOCE), launched at the beginning of 2009, the Soil Moisture and Ocean Salinity mission (SMOS), launched in November 2009, and CryoSat, which launched in April 2010.

The German division of Astrium was responsible for manufacturing the satellites; other participating German companies include, among others, IABG (Industrieanlagen-Betriebsgesellschaft mbH), ZARM Technik AG, Altran and Xperion. The operating company for the Rockot launcher is Eurokot Launch Services GmbH. The rocket was launched from Plesetsk, 800 kilometres north of Moscow. The launch, separation from the launcher, orbit injection and ongoing flight operations are being monitored by the European Space Operations Centre (ESOC) in Darmstadt.

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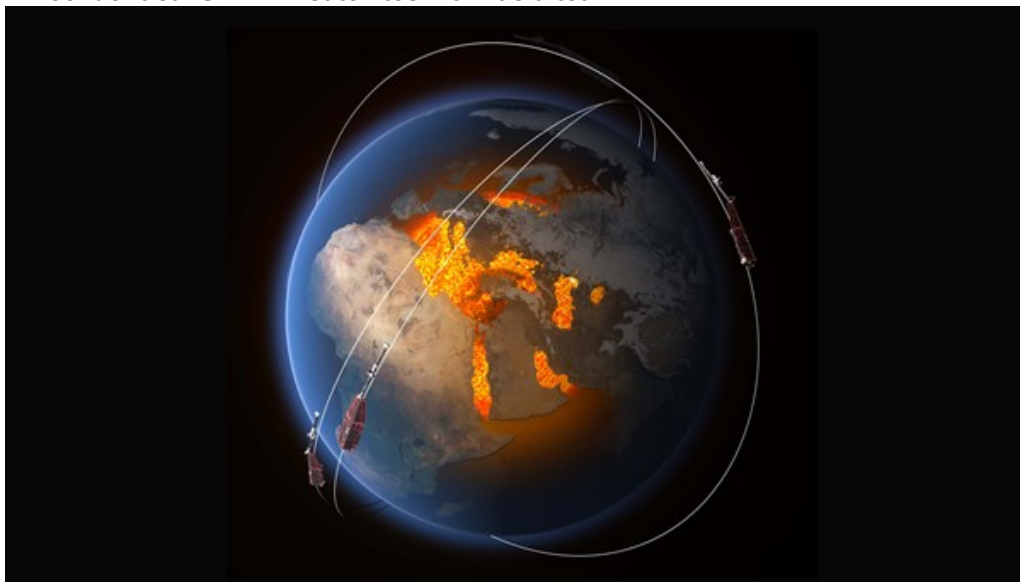
## Launch of the three SWARM satellites from Plesetsk



On Friday 22 November at 13:02 CET (12:02 GMT) the three European SWARM satellites were lifted into orbit from the Plesetsk Cosmodrome in northern Russia by a Rockot launch vehicle.

Credit: ESA.

## Three identical SWARM satellites work as a team



Teamwork: the flight constellation and high-precision instruments of three identical satellites allows for highly accurate measurements of Earth's magnetic field. They orbit the Earth in near polar orbits. Two of the satellites have an east-west separation of 1 to 1.4 degrees, and the third satellite, which completes the constellation, is about 100 kilometres above them. This formation allows for the magnetic field to be recorded simultaneously in several positions.

Credit: ATG Medialab/ESA.

### Three in a row



The three identical SWARM satellites waiting to be mounted on the Rockot launch vehicle at the Plesetsk Cosmodrome in northern Russia.

Credit: Shafiq/ESA.

### DLR Project Office for the SWARM mission at GFZ Potsdam



Miriam Langhans coordinates scientific and technical use of the SWARM results by German companies and research institutions, via the DLR Project Office at the German Research Centre for Geosciences in Potsdam.

Credit: GFZ Potsdam.

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