GOCE

Gravity field and steady-state Ocean Circulation Explorer
Mapping Earth's Gravity field as never before

The first of a series

Addressing the challenges of global change, Europe is launching the GOCE satellite to map our planet's gravity field in unprecedented detail. As part of ESA's Living Planet Programme, GOCE is the first of a series of Earth Explorer satellites in orbit, designed to provide information for understanding climate change as well as other critical Earth system variables.

Looking into the forces that shape our planet

Clarified by Isaac Newton in the 17th century, gravity is a fundamental force of nature. Everything that has mass is pulled by gravity. As Earth is not a perfect sphere and its interior has layers and zones of different density, gravity varies around the globe.

Gravity and its variation in space are fundamental to every dynamic process on Earth's surface and in its interior. Improving our knowledge of how gravity affects the interaction between these processes has practical benefits in today's changing world. An accurate gravity map – the geoid – is also crucial for geodesy applications and for defining a sea surface height reference model with which to accurately survey ocean circulation patterns and sea-level changes.

A technological achievement

With its unique design, this 'Ferrari' of satellites demonstrates Europe's excellence in both engineering and science through the realisation of one of the most challenging space missions to date.

The GOCE payload includes:

- a gradiometer. With its three pairs of accelerometers, this state-of-the-art instrument will measure gravity with unprecedented accuracy. Within its measurement band, each accelerometer can detect accelerations to within 1 part in 10 000 000 000 000 of Earth's surface gravity.
- a Global Positioning System (GPS) receiver. To ensure such precise measurements, GOCE's own position must be precisely known at all times. The positions provided via GPS will also supply gravity information through analysis of the perturbations in GOCE's orbit.
- a Laser Retro Reflector. This will enable very accurate tracking of the spacecraft by terrestrial lasers.

An intimate portrait of Earth

The high-resolution gravity measurements of GOCE will:

- contribute to improved climate models by providing new knowledge on how gravity affects ocean circulation and sea level
- provide a new understanding of Earth's interior, including magma distribution under volcanoes, thereby improving our knowledge of tectonic movements and seismic hazards.
- underpin a worldwide height system, supporting applications such as construction, planning and surveying as well as providing a reference sea-surface level.
- in combination with other data sets, improve estimates of the thickness and mass of the polar ice sheets, crucial witnesses of climate change effects.

Facts and figures

- launch 10 September 2008
- launcher: Rockot (with Breeze-KM upper stage) by Eurockot Launch Services GmbH
- launch site: Plesetsk Cosmodrome, Russia
- mission control: European Space Operations Centre (ESOC), Darmstadt, Germany
- data download: to Kiruna (Sweden) and Svalbard (Norway) ground stations
- processing & archiving: ESA's Earth observation centre in Italy (ESRIN) and the distributed High-level Processing Facilities
- number of instruments: 3
- nominal life: 20 months
- mission cost: €340 million (including launcher and operations)
- orbit: about 260 km altitude, polar, Sun-synchronous
- mass: 1100 kg
- size: 5.3 m long, about 1 m body diameter
- propulsion tank: 40 kg of xenon
- geoid accuracy: 1–2 cm vertically with 100 km spatial resolution
- gravitational acceleration at Earth's surface is about 9.8 m/s^2, varying from a minimum of 9.788 m/s^2 at the equator to a maximum of 9.838 m/s^2 at the poles
- the six accelerometers (three pairs in three orthogonal directions) are some 100 times more sensitive than any previously flown in space
- planning and construction of the GOCE spacecraft involved 45 European companies led by Thales Alenia Space

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