

The satellite mission GRACE & GRACE-FO

Gravity Recovery and Climate Experiment

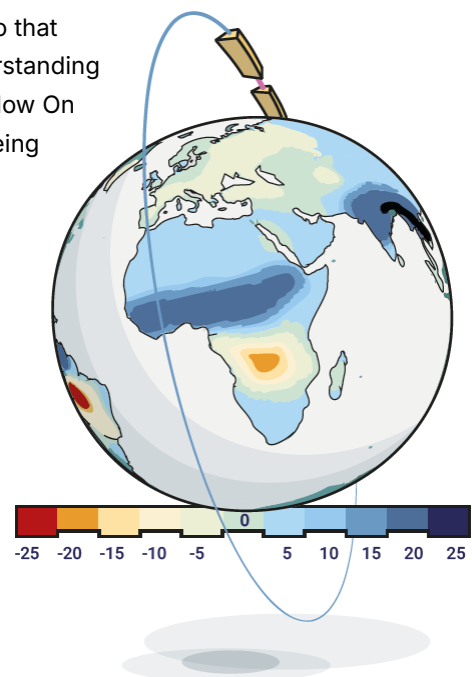


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Key messages

- GRACE and GRACE-FO are unique German-American satellite missions for climate and environmental monitoring. The data collected is used to document temporal and spatial variations of the Earth's gravity field and related large-scale mass transports, such as the distribution of global water masses.
- The GRACE missions are based on the precise measurement of the distances and derived velocities and accelerations between two identical satellites in a polar orbit.
- The measurement principle realised with the satellite pairs is the only method that can observe changes in the water cycle on and far below the Earth's surface. In this way, changes in the terrestrial water storage, including groundwater, as well as the melting of continental ice masses in the Arctic and Antarctic or the contribution of meltwater in sea level rise can be monitored.
- If possible, data should be collected over at least three decades so that reliable statistics can be compiled that contribute to a better understanding of climate change. Following GRACE (2002–2017) and GRACE-Follow On (since 2018), the launch of the new mission GRACE-C mission is being prepared for 2028.

Example of a data visualisation
of the terrestrial water storage
(blue = much water, red = little water)
on a globe with the GRACE
satellites in a polar orbit.
(Graphic: GFZ/M. Künsting)



FAQ – Key questions and answers

What are the GRACE satellites measuring?

Two identical satellites orbit the Earth at an altitude of around 490 kilometres and at a separation of around 220 kilometres. The orbit always takes place over both poles and lasts around 90 minutes. The satellite pairs measure monthly and spatial (approx. 300 km pixel size) changes in the Earth's gravitational field. They "see" mass variations, for example the winter growth and summer melting of the polar ice sheets, but also strong mass changes in regions such as California or Western Europe due to unusually low or high levels of precipitation. These observations are important for our understanding of the global water cycle and its development in a changing climate.

What happens with the data?

The GFZ uses the data to calculate monthly maps of the gravity field and derives the variations in the global water cycle. The data and maps are available to researchers worldwide free of charge and without access restrictions, for example via the GFZ portal gravis.gfz-potsdam.de.

More than [3,000 scientific publications](#) in scientific journals are based on data from GRACE and GRACE-FO. In addition, the results are also made available to the general public on a dedicated information platform.

Information portal: globalwaterstorage.info/en/

What missions have there been so far and what's next?

GRACE and GRACE-FO are joint projects between Germany and the USA. Airbus built all four satellites in Immenstaad (Germany) on behalf of NASA. Mission operations are carried out at the German Space Operations Centre of the German Aerospace Centre in Oberpfaffenhofen. The GFZ Helmholtz Centre for Geosciences is responsible for the scientific management of the missions.

GRACE was launched in March 2002 and ended in December 2017. The successor mission GRACE-FO was launched in May 2018 and has flown without major hitches so far. Its nominal mission duration ended in May 2023, current predictions suggest a mission lifetime till about 2028/29. Overall, this has resulted in a unique long-term series of monthly gravity field maps over the past 22 years.

The aim of the continuation mission GRACE-C is to map at least seven more years in a comparable way from 2029 in order to collect data over a complete 30-year climate period. In addition, prototypes for operational services are currently being developed, such as global groundwater monitoring, which depend on the future availability of data. A continuous series of measurements is therefore essential in order to better assess climate change at regional and global scales and to decide on necessary management measures.