GFZ Helmholtz Centre for Geosciences

marek - stock.adobe.com

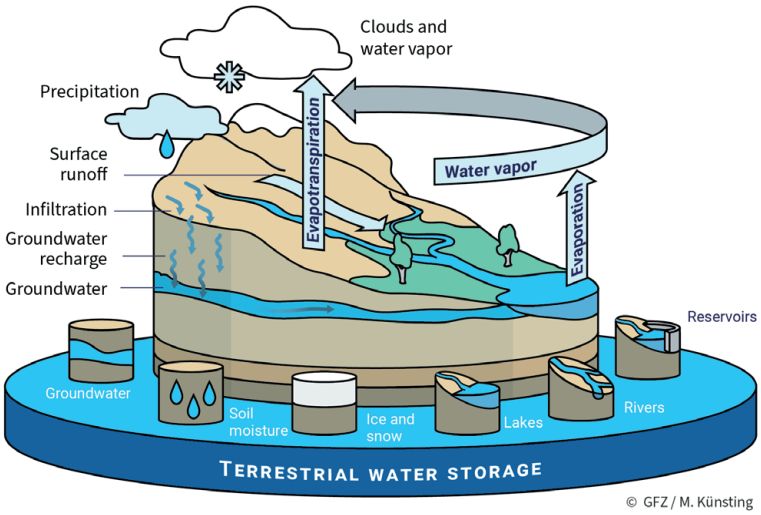
# Terrestrial water storage

## Key messages

- Terrestrial water storage is a state variable of the global water cycle and reflects water availability and storage changes.
- The GRACE and GRACE-FO satellite missions are able to monitor the terrestrialstorage of water and monitor its changes over time.
- By measuring terrestrial water storage, changes in other storage compartments like groundwater can also be estimated.
- Terrestrial water storage has been defined an essential climate variable by Global Climate Observing System (GCOS)

## Frequently Asked Questions

### What is terrestrial water storage?

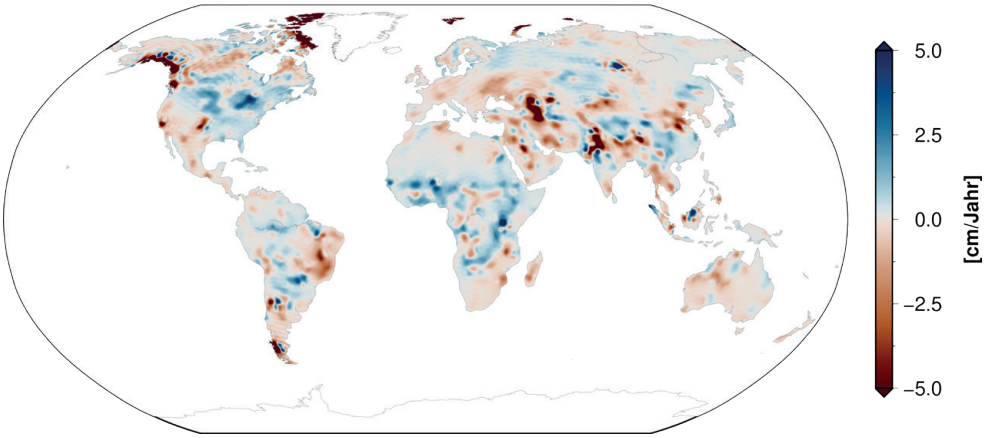



© GFZ / M. Künsting

The continental part of the water cycle comprises precipitation over the land surfaces, evaporation (from water surfaces, soil, and vegetation, and from anthropogenic sources like industry and energy production plants), infiltration, and surface and subsurface runoff back into the oceans. Terrestrial water storage (TWS) is a state variable of the global water cycle that includes various storage compartments on the continents, like snow, ice, surface water, water stored in vegetation, soil moisture and groundwater.

## What is the advantage of measuring terrestrial water storage with the GRACE satellites?

Extreme fluctuations in terrestrial water storage are often associated with floods and droughts, as they are caused by either a water surplus or deficit. The GRACE satellites measure terrestrial water storage as mass displacement and thus record not only surface or near-surface storage changes but also the water in deeper layers and the groundwater. This makes it easier to estimate the long-term effects of heavy rainfall or longer dry periods, which otherwise could often only be observed with a large time delay.




*Trend for terrestrial water storage (2002–2021). The regions with a water deficit are marked in red, those with a water surplus in blue. (Map: E. Boergens/GFZ)*

## What do the GRACE satellites have to do with groundwater?

Groundwater is a significant source of freshwater, both for humans and for Earth's ecosystems. Groundwater is formed by infiltration from the earth's surface and percolation into deeper layers of soil and rock, and it accumulates in aquifers. The formation of groundwater is a comparably slow process. Recharge can take months to years. Comprehensive observation of groundwater is very cost- and time-intensive. However, GRACE and GRACE-FO can also be used to monitor groundwater by measuring terrestrial water storage. An approach to do this is to subtract the other components of the water cycle, which are usually easier to observe and measure, from terrestrial water storage in order to obtain groundwater storage changes. Groundwater as a resource is under threat in many parts of the world. This makes it all the more important to monitor long-term changes.

## What is the significance of terrestrial water storage?

Due to the great importance of terrestrial water storage for the global water cycle and its sensitivity to the impact of climate change, terrestrial water storage was defined as one of 54 Essential Climate Variables (ECVs) by the Global Climate Observing System (GCOS). ECVs are state variables of the Earth's system that can be used to characterise the Earth's climate and its changes. GRACE and GRACE-FO form the basis for providing a freely accessible climate data set for terrestrial water storage in line with GCOS recommendations.

**GFZ Helmholtz Centre for Geosciences**
www.gfz.de/en

**Further questions?**
Contact us via
globalwaterstorage.info/en/contact