

# Integrated glacier monitoring: strategy and datasets of the Global Terrestrial Network for Glaciers

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## About

Changes in glaciers and ice caps provide some of the clearest evidence of climate change and have impacts on global sea-level fluctuations, regional hydrological cycles and local natural hazard situations. Internationally coordinated collection and distribution of standardized information about the state and change of glaciers and ice caps was initiated in 1894 and is today coordinated within the Global Terrestrial Network for Glaciers (GTN-G).

A GTN-G Steering Committee coordinates, supports and advises the operational bodies responsible for the international glacier monitoring, which are the World Glacier Monitoring Service (WGMS), the US National Snow and Ice Data Center (NSIDC), and the Global Land Ice Measurements from Space (GLIMS) initiative.

Consistency and interoperability of the different glacier databases (FoG, WGI, GLIMS, GPC) are elaborated by joint efforts within the project's partners and network. Thereby, different historical developments and methodological contexts of the datasets are major challenges for linking individual glaciers throughout the databases.

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## Fluctuations of Glaciers (FoG) Front variations

Regular observations of horizontal changes in the position of the glacier terminus have been reported and published since the end of the 19th century. Today, more than 42,000 length change observations from 2,300 glaciers are available throughout the world.



Length change observation (Photo by S. Kappeler)

## Fluctuations of Glaciers (FoG) Mass balance

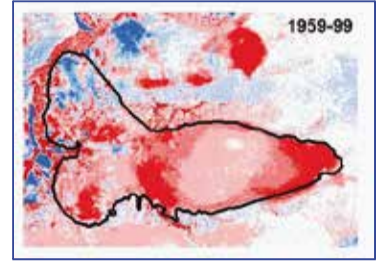
Glacier-wide mass balance measurements have been carried out since the 1940s. Mass balance data is available from about 400 glaciers worldwide. There are 37 mass balance programmes with continuous observation series since 1976 or earlier.



Ablation stake, snow pit measurement (Photos by D. Vonder Muhl, M. Hoelzle)

## Fluctuation of Glaciers (FoG) Geodetic changes

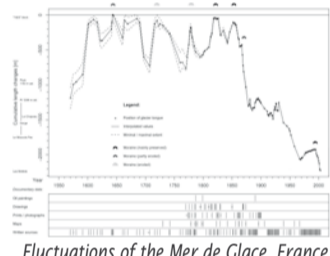
Geodetic thickness or volume changes, as derived from terrestrial or remote sensing methods, are available for 450 glaciers worldwide.



Thickness change of Storglaciären, Sweden (Koblet et al. 2011)

## Fluctuations of Glaciers (FoG) Reconstruction series

Reconstructions of glacier front variations based on well-dated historical evidence extend the observational record back to the 16th century. Fluctuation series are available for 36 glaciers.



Fluctuations of the Mer de Glace, France (Nussbaumer et al. 2007)

## Fluctuations of Glaciers (FoG) Special events

Information on 420 glacier-related special events which may pose threats to human activities, such as glacier surges, outbursts of lakes, ice avalanches, drastic retreat or advance of tidal glaciers or eruptions of ice-clad volcanoes have been reported from 290 glaciers.



Ice avalanche (Photo by J. Alean, www.swisseduc.ch)

## WGI database

A first approach to compile a World Glacier Inventory (WGI), mainly based on aerial photographs and maps, resulted in a dataset of coordinates and detailed tabular information for over 130,000 glaciers with an overall area of 240,000 km<sup>2</sup> and preliminary estimates for the remaining ice cover.

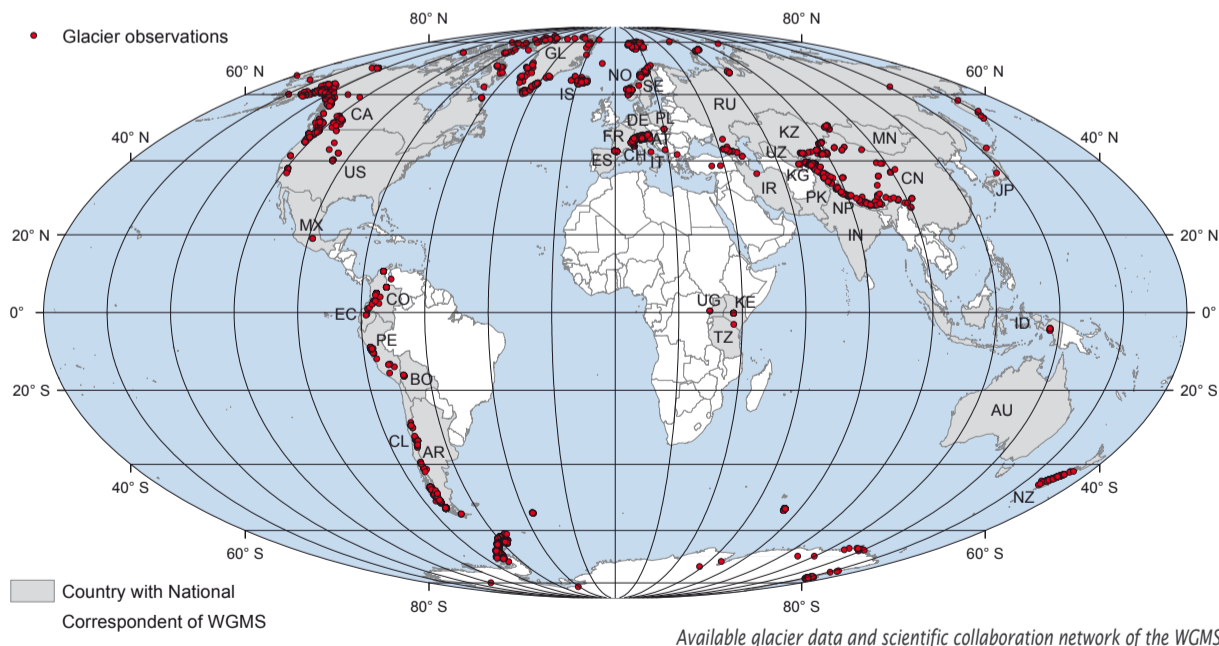


Glacier inventory in the Alps (Figure by M. Zemp)

## Network of the World Glacier Monitoring Service

The WGMS is a service of the International Association of the Cryospheric Sciences of the International Union of Geodesy and Geophysics (IACS, IUGG) as well as of the World Data System of the International Council for Science (WDS, ICSU) and works under the auspices of the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the World Meteorological Organization (WMO).

As a contribution to the Global Terrestrial/Climate Observing System (GTOS, GCOS), the Division of Early Warning and Assessment and the Global Environment Outlook of UNEP, and the International Hydrological Programme of UNESCO, the WGMS collects and publishes worldwide standardized glacier data. Thereto, the WGMS maintains a network of local investigators and national correspondents in all countries involved in glacier monitoring.



The WGMS combines traditional methods with innovative application and strategies of ground- and remote sensing-based monitoring to observe ongoing, and to assess past and possible future changes in mountain systems. Needs for sustainable (long-term) glacier monitoring in target regions are analysed, and capacity building and twinning activities are carried out, such as the organization of summer schools and the hosting of guest scientists at the WGMS at the University of Zurich, Switzerland.

## GLIMS database

The Global Land Ice Measurements from Space (GLIMS) initiative was launched to continue the inventorying task with space-borne sensors storing glacier outlines and detailed tabular information. At present, the database contains 160,000 glaciers.



Repeat inventories, Baffin Island, Canadian Arctic (Figure by F. Svoboda)

## Glacier photo collection

The Glacier Photograph Collection (GPC) contains more than 14,000 photographs from some 500 glaciers. Such overview pictures and repeat photographs back to the late 19th century constitute an important historical record and valuable meta-data to the other scientific datasets.



Photos: NSIDC/USGS by W.O. Field (1941), B.F. Molnia (2004)

## WGMS MetaData Browser



All glacier fluctuation datasets are digitally available through the WGMS website and the WGMS MetaData Browser. The glacier fluctuation database is completed by specific index datasets, e.g. glacier thickness data. All data and information is freely available for scientific and educational purposes under requirement of correct citation of the database or data source.

www.wgms.ch

www.nsidc.org

www.glims.org

www.gtn-g.org

The WGMS receives substantial funds for the operations of the central service from the Swiss GCOS Office at the Federal Office of Meteorology and Climatology MeteoSwiss, and the Department of Geography, University of Zurich, Switzerland. The Swiss Agency for Development and Cooperation (SDC), through the "Sustainable Mountain Development for Global Change (SMD4GC)" programme is supporting WGMS capacity building and twinning activities.