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# Ice and Climate

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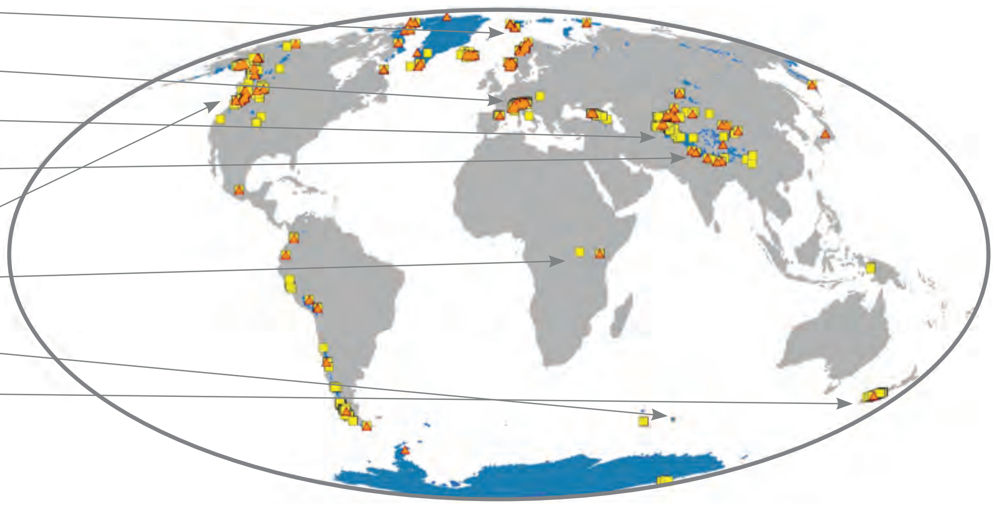
*"... glaciers at the summit of Kilimanjaro are a product of climatic conditions which no longer exist..."*

## Editorial

### Mountain Cryosphere

The effects of global warming – shrinking glaciers, reduced snow-cover duration, melting permafrost, etc – are already clearly visible in most mountain regions. Mountain glaciers are the source of water for over half of humanity, yet almost everywhere they are rapidly disappearing, and many have already disappeared.



Worldwide Glacier Monitoring. The global distribution of surface ie on land (blue) is shown with locations of glacier front variation (yellow squares) and mass balance (orange triangles) measurements. Data source: locations of glacier observations provided by the WGMS, Zurich, Switzerland; background glacier cover is based on the glacier layer of the Digital Chart of the World, provided by the NSIDC, Boulder, USA.

In many locations permafrost and frozen ground is warming, and the seasonal snow cover is deceasing. These changes in the cryosphere will have significant social and economic impacts relating to such things as water supplies, tourism, infrastructure and development. A recent UNESCO report[1] identified a number of World heritage sites at risk from Huascaran National Park in Peru, to Sagarmatha National Park in Nepal to the archaeological sites in the Golden Mountains of Altai in the Russian Federation. Both the Andes and the Himalaya face the prospect of first increase risks of floods from melting and Glacial Lake Outburst Floods (GLOF's) and then a decrease in water supplies to large population centers (pg 12). Other hazards such as avalanches, melting permafrost and increased rock glacier speeds are discussed in more detail in this newsletter. The impact of these changes is not limited to the mountain regions. For example, glacier melt water contributes substantially to recent sea level rise and may alter global ocean circulation.

Mountains regions are home to both some of the wealthiest, and some of the poorest communities, which is reflected in the wide range of strategies and resources which are available to mitigate and/or adapt to changes. The response to these impacts ranges from sophisticated engineering solutions for structures on permafrost (pg 9)

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# Worldwide Glacier Monitoring – Present State and Current Challenges

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Due to their proximity to melting conditions, glaciers are among the most climate-responsive components of the solid Earth and thus offer essential variables required for global climate monitoring. Worldwide collection of information about ongoing glacier changes was initiated in 1894 with the foundation of the International Glacier Commission at the 6th International Geological Congress in Zurich, Switzerland. Today, the World Glacier Monitoring Service (WGMS; <www.wgms.ch>) continues to collect and publish standardised information on ongoing glacier changes. WGMS is a service of the Commission for the Cryospheric Sciences of the International Union of Geodesy and Geophysics (CCS/IUGG) and maintains a network of local investigators and national correspondents in all the countries involved in glacier monitoring. The WGMS is in charge of the Global Terrestrial Network for Glaciers (GTN-G) within the Global Climate/Terrestrial Observing System (Haeberli *et al.*, 2000). GTN-G aims at combining (a) in-situ observations with remotely sensed data, (b) process understanding with global coverage and (c) traditional measurements with new technologies by using an integrated and multi-level strategy (Haeberli, 2004).

The WGMS hosts an unprecedented dataset of information about spatial glacier distribution and changes over time which is readily available to the scientific community and the public. At present, the database contains about 34,000 front variation and 3,000 annual mass balance observations for 1,725 and 200 glaciers, respectively (see figure on front page). The World Glacier Inventory (WGI, 1989) makes available information on location, classification, area, length, orientation and altitude range for over 71,000 glaciers (mainly from aerial photographs and maps). This corresponds to about 44% of the total number and 23% of the total area of all glaciers and ice caps worldwide (cf. estimates by Dyurgerov and Meier, 2005). The Global Land Ice Measurements from Space (GLIMS; http://nsidc.org/glims) initiative was designed to continue this inventorying task with space-borne sensors (cf. Kieffer *et al.*, 2000) in close cooperation with the National Snow and Ice Data Center (NSIDC; <www.nsidc.org>) and the WGMS. A new project (GlobGlacier), under the lead of F. Paul (University of Zurich), is proposed to the European Space Agency and aims at making a major contribution to the current GLIMS database <http://dup.esrin.esa.int/projects/summaryp98.asp> (see pg 5).

Under the present climate scenarios (cf. IPCC, 2007), the ongoing rapid and perhaps accelerating trend of worldwide glacier shrinkage, on the century time-scale, is of a non-periodical nature and may lead to the deglaciation of large parts of many mountain ranges within the coming decades (Zemp *et al.*, 2007). To keep track of these fast environmental changes and to assess corresponding impacts on landscape evolution, fresh water supply and natural hazards, monitoring strategies will have to make use of the rapidly developing new technologies (remote sensing and geoinformatics) and relate them to the more traditional methods. Such challenges of historical dimensions, both with respect to changes in nature and science, can only be faced by a strong, operational monitoring service that has a well organised international structure and a secure financial basis from national and international funding, independent of any short-term scientific project money.

During the International Polar Year (IPY; 2007–2008), the WGMS is helping to coordinate glacier related IPY-projects in cooperation with NSIDC, GLIMS and the IPY Data and Information Service (IPYDIS; <http://nsidc.org/ipydis>). Scientists with glacier-related projects are invited to contact WGMS for available data, internationally approved standards for glacier monitoring, and for data submission guidelines.

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