Geophysical Research Abstracts,
Vol. 10, EGU2008-A-03055, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-03055
EGU General Assembly 2008

International monitoring of glaciers and ice caps, and their contribution to present and potential sea level changes

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Glaciers are among the most dynamic elements of the solid Earth and are important freshwater resources, but they also pose serious natural hazards. Because they are close to the melting point and react strongly to climatic changes, glaciers provide some of the clearest evidence of climate change, and are a significant contributor to sea level changes.

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; http://www.wgms.ch) continues to collect and publish standardised information on ongoing glacier changes. The WGMS maintains a network of local investigators and national correspondents in all the countries involved in glacier monitoring and is in charge of the Global Terrestrial Network for Glaciers (GTN-G) within the Global Climate/Terrestrial Observing System. 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.

This presentation aims at giving an overview of the present state and challenges of

GTN-G, i.e., of the current front variation and mass balance monitoring programmes, as well as of the world glacier inventory, and discusses the contribution of glaciers and ice caps to current and potential sea level changes.

Systematic observations of glacier front variation and mass balance started in the second half of the 19th and 20th century, respectively. At the turn of the 21st century, annual front variation and mass balance measurements were reported from about 750 and 100 glaciers, respectively. A first attempt to compile a world glacier inventory was done in the 1980s (mainly from aerial photographs and maps), when detailed information on glacier location, area, length, orientation, elevation and classification of over 71 000 glaciers were collected, corresponding to about 44% of all glaciers and ice caps worldwide. In close cooperation with the National Snow and Ice Data Center (NSIDC; http://www.nsidc.org) and the WGMS, the Global Land Ice Measurements from Space (GLIMS; http://nsidc.org/glims) project was designed to continue this task with space-borne sensors.

Since the end of the Little Ice Age, most glaciers around the globe have been shrinking significantly, with increasing rates of ice loss since the mid-1980s. On a time-scale of decades, glaciers in various mountain ranges have shown intermittent re-advances. Under current IPCC climate scenarios, the ongoing trend of worldwide and fast, if not accelerating, glacier shrinkage on the century time-scale is most likely of a non-periodic nature, and may lead to the deglaciation of large parts of many mountain ranges by the end of the 21st century.

The mass loss of glaciers and ice caps (excluding peripheral ice bodies around the two ice sheets in Greenland and Antarctica) between 1961 and 1990 is estimated to have contributed 0.33 mm per year to the rising sea level, with about a doubling of this rate in the period from 1991 to 2004. The overall sea level rise equivalent of glaciers and ice caps was quoted in the latest IPCC report to be between 150 mm and 370 mm (i.e., if all glaciers and ice caps melted away). However, this estimate does not include the peripheral ice bodies around the two ice sheets and, hence, might significantly underestimate the potential contribution of glaciers and ice caps to future sea level changes.