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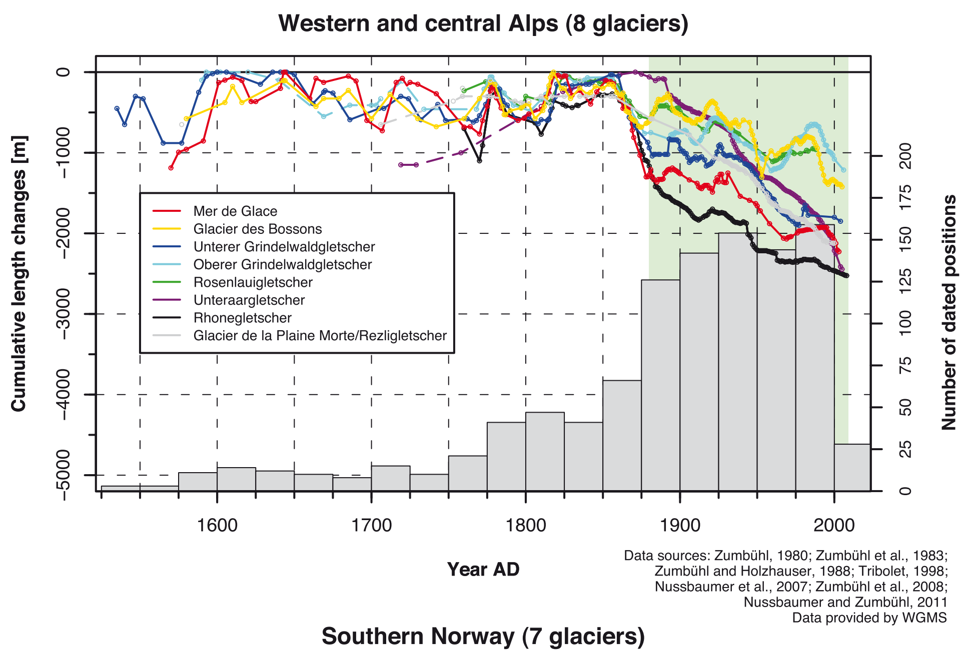
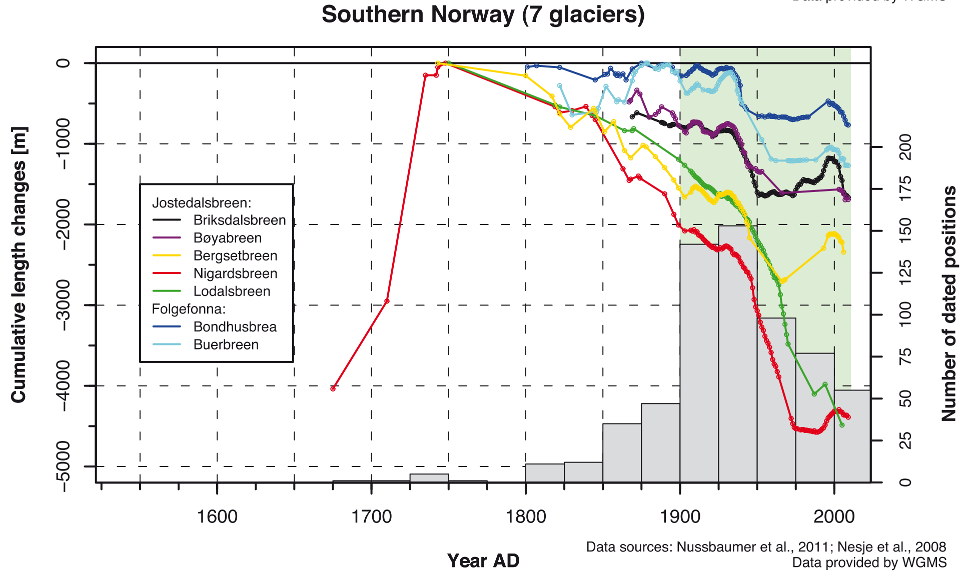
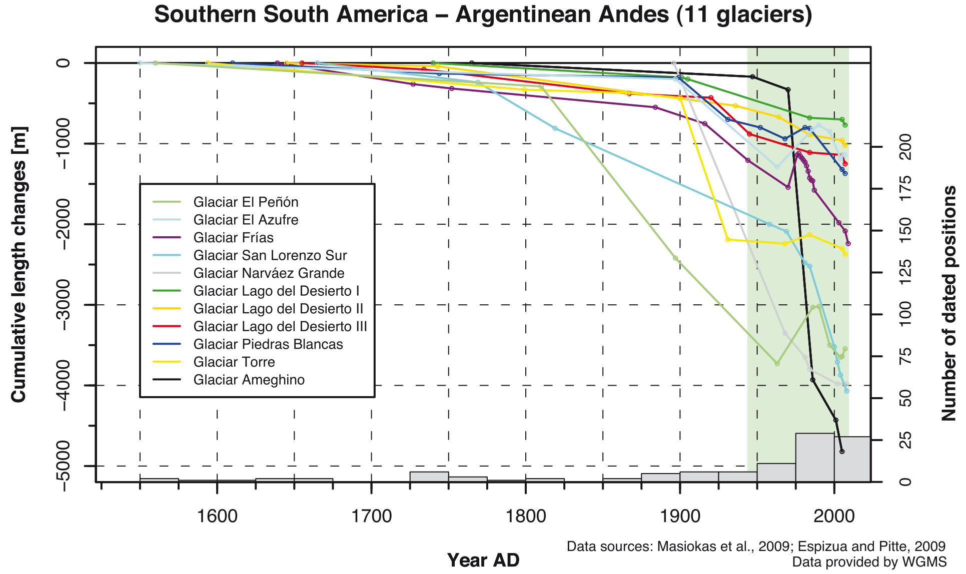
Extending Glacier Monitoring into the Little Ice Age and Beyond

S. U. Nussbaumer[1,2,3], I. Gärtner-Roer[1], M. Zemp[1], H. J. Zumbühl[2], M. H. Masiokas[3], L. E. Espizua[3] and P. Pitte[3]

[1] World Glacier Monitoring Service, Department of Geography, University of Zurich, Switzerland, [2] Institute of Geography and Oeschger Centre for Climate Change Research, University of Bern, Switzerland,
[3] Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA), CCT-CONICET Mendoza, Argentina (E-mail: **samuel.nussbaumer@geo.uzh.ch**)







Reconstructions of glacier front variations based on well-dated historical evidence from the Alps, Scandinavia and the southern Andes extend the observational record as far back as the 16th century. The standardized compilation of paleo-glacier length changes is now an integral part of the internationally coordinated glacier monitoring system.

The storage in standardized database formats allows a direct comparison of cumulative length changes between different glaciers as shown in the figure below. Thereby, a first data table contains summary information of the entire reconstruction series including a plot of the data and meta-data (see figure to the right), investigator information, and references. A second table stores the individual glacier front variation data, minimum and maximum glacier elevation, and meta-data related to the reconstruction methods and uncertainties.

The reconstructed front variations extend the direct observations (mostly from the 20th century) by two centuries in Norway and by four centuries in the Alps and South America. Also available are moraines data back to the mid-Holocene.

The standardized compilation and free dissemination of reconstructed and *in situ* observed glacier fluctuation records offer several benefits for both data providers and users. Their incorporation within the international glacier databases guarantees the long-term availability of the data series and increases the visibility of the scientific results (which in historical glaciology are often the work of a lifetime). Furthermore, the database facilitates comparisons between glaciers and between different methods, and opens the field to numerous scientific studies and applications.

As the next steps of this new initiative, we aim to:

(1) **integrate a greater number of time series**,
(2) **incorporate records that cover the entire Holocene**, and
(3) **include data from other regions** (e.g., the Himalayas, North America).

Ideally, the growing new dataset will facilitate collaboration between the glacier monitoring and reconstruction communities and become an additional tool for the comparison of present-day to pre-industrial climate changes.

For full details and references, see Zemp *et al.*, *PAGES News* 19(2), 67–69 (2011).

Figures to the left:
Reconstructed and measured cumulative glacier front variations in the Alps, Norway and southern South America since the Little Ice Age (LIA). The zero value on the y-axis corresponds to the most extensive front position of glaciers during the LIA. The period with direct front measurements is indicated by light green background. Gray vertical bars show the total number of available data for the selected glaciers. Note the significantly lower number of data points available from the Southern Andes.

wgms World Glacier Monitoring Service

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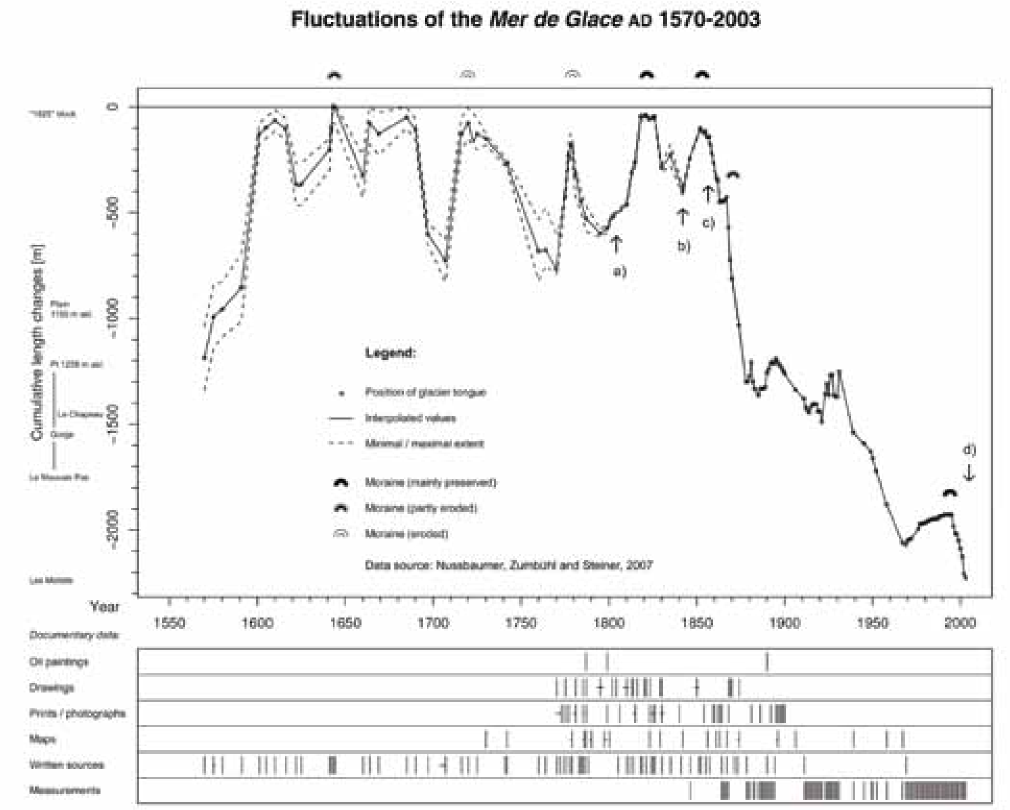

Example of available meta-information stored within the database:
Fluctuations of the Mer de Glace, France, during and following the Little Ice Age (LIA), reconstructed from a variety of sources (Nussbaumer et al., 2007). Length changes (relative to AD 1644 = maximum of LIA) were derived from documentary data as shown in the compilation below the x-axis, where small horizontal lines indicate uncertainties concerning the date of the document. Landmarks are indicated beside the y-axis. In situ measurements for the 1911–2003 period were obtained from the Laboratoire de Glaciologie et Géophysique de l'Environnement in Grenoble.
*Images a–d: The Mer de Glace (**a**) in 1804 drawn by Jean-Antoine Linck, (**b**) in 1842 mapped by James David Forbes, (**c**) in the 1850s photographed by Henri Plaut, and (**d**) in 2005 (Nussbaumer et al., 2007).*

Data request and submission of data to the international glacier databases:

Worldwide collection of standardized data on the distribution and changes of glaciers has been internationally coordinated since 1894. Today, the World Glacier Monitoring Service (**www.wgms.ch**) is in charge of the compilation and dissemination of glacier datasets in close collaboration with the U.S. National Snow and Ice Data Center (**www.nsidc.org**) and the Global Land Ice Measurement from Space initiative (**www.glims.org**) within the framework of the Global Terrestrial Network for Glaciers (**www.gtn-g.org**).
The WGMS database contains detailed inventory information of about 100,000 glaciers worldwide. In addition, *in situ* observations of frontal variations of 1,800 glaciers, mass balance data of 250 glaciers, and reconstructed frontal variations of the 26 glaciers mentioned above are now readily available in standardized and digital form.

For available data or guidelines on data submission please check the websites and/or directly contact: **wgms@geo.uzh.ch**