

Glacier length fluctuations in the Alps and in southern Norway back to the 16th century based on historical data

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The understanding of past and present glacier variations is a key task for evaluating current climate change. Historical and proxy-records have documented that there is a substantial asynchronous development in temperature, precipitation and glacial variations between European regions during the Little Ice Age (LIA), and the causes of these temporal anomalies are yet poorly understood. Here we present temporally high-resolved glacier reconstructions based on historical data for the central and western European Alps. Moreover, historical material recently compiled for glaciers in southern Norway (Folgefonna, Jostedalbreen) allows the comparison of glacier fluctuations in the Alps and in Scandinavia during the LIA.

Only exemplary glaciers well-documented regarding historical information are suitable for the determination of glacier fluctuations for the last 400-500 years. Length changes can be determined by the interpretation of historical pictorial documents such as drawings, paintings, prints, photographs and maps, as well as written sources. A rigorous selection and critical assessment of the quality of the documentary data is necessary in order to get reliable information on past glacier extents (1). Besides, other evidence such as moraine findings, fossil trees in the glacier forefield and archaeological findings are also considered and complete the task. This approach allowed the reconstruction of glacier length changes for the well-known Mer de Glace (Mont Blanc area, France) back to the year 1570 (2).

The glacier record presented here includes glaciers in the central and western Swiss Alps (Lower and Upper Grindelwald, Rosenloui, Unteraar, Rhône Glaciers, Glacier de la Plaine Morte) and in the French Mont Blanc area (Mer de Glace, Glacier des Bossons). The compilation shows main glacier advances around 1850, 1820, 1780 and in the first half of the 17th century. However, glaciers in southern Norway (Folgefonna, Jostedalbreen) show a highly different evolution, which is historically well-documented e.g. at Nigardsbreen (LIA maximum extent in the mid 18th century, vs. maxima in the Alps in the 17th and 19th century).

The record allows assessing the spatial distribution of glacier fluctuations in the studied areas during the last few centuries. In combination with climate reconstructions for the European Alps and for Scandinavia (3, 4), this can give a better understanding of the

influence of European climate dynamics on glaciers during the last half millennium. The comparison between these two areas is very promising because of their different behaviour related to the North Atlantic Oscillation (NAO). Annual net mass balances on glaciers in the Alps show rather complex relations to the NAO dynamics. On the other hand, annual mass balances on maritime (coastal) glaciers in southern Norway are mainly in phase with the winter NAO index. For instance, the rapid glacier advance in the early 18th century in southern Norway was mainly due to increased winter and/or spring precipitation (positive trend in the winter NAO index) (5, 6).

This implies that the cause for the different timing of the LIA glacier maxima in Scandinavia and in the Alps may be related to differences in regionally, seasonally resolved temperature and precipitation distribution which themselves are determined by changes in the large-scale atmospheric circulation over the northern North Atlantic/European area. However, the circulation and hence the circulation-driven distribution of precipitation and temperature and glacier dynamics is more complex than can be explained from simple circulation indices such as the NAO index alone, and the influence of climate modes may also be non-stationary during time.

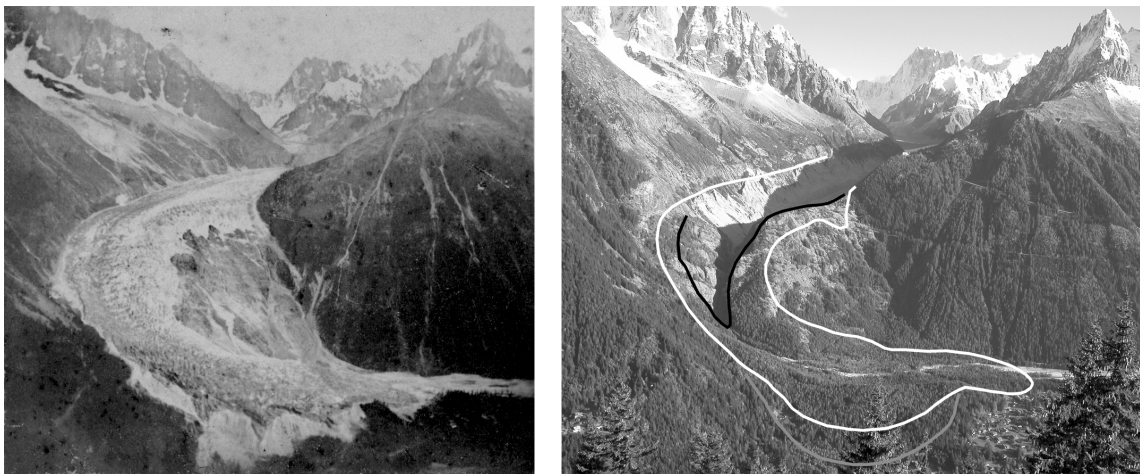


Figure 1. Left: Photograph showing the advanced Mer de Glace in the 1850s. Right: Maximum extents of the Mer de Glace in 1644 (grey line), 1821 (white) and 1895 (black).

Key references:

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