

Historical glacier fluctuations of Jostedalsbreen and Folgefonna, southern Norway, reassessed by new documentary evidence, and their connection to climate

Samuel U. Nussbaumer (1, 2, 3), Atle Nesje (4, 5), Daniel Steiner (6), Heinz J. Zumbühl (1, 2)

1 Institute of Geography, University of Bern, Hallerstrasse 12, CH-3012 Bern, Switzerland

2 Oeschger Centre for Climate Change Research, University of Bern, Zähringerstrasse 25, CH-3012 Bern, Switzerland

3 Department of Geography, University of Zurich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland

4 Department of Earth Science, University of Bergen, Allégaten 41, N-5007 Bergen, Norway

5 Bjerknes Centre for Climate Research, Allégaten 55, N-5007 Bergen, Norway

6 Pädagogische Hochschule Zürich, Fachbereich Mathematik, Kantonsschulstrasse 3, CH-8090 Zürich, Switzerland

E-mail corresponding author: samuel.nussbaumer@geo.uzh.ch

Glaciers are sensitive indicators of past climate and thus valuable sources of climate history. To reconstruct glacier variability for the time before the onset of direct measurements, historical and geomorphological evidence has to be used. Here we present new glacier length reconstructions for selected outlet glaciers of Jostedalsbreen and Folgefonna in southern Norway. A wealth of different historical sources (drawings, paintings, prints, photographs, maps, written accounts; about 400 documents) allows reconstruction of glacier length variations for the last 300 (Jostedalsbreen), and 200 years (Folgefonna), respectively. We present historical material newly collected for Briksdalsbreen, Bøyabreen, Store Supphellebreen, Bergsetbreen, Nigardsbreen, Lodalsbreen (all Jostedalsbreen), and Bondhusbreen, Buerbreen (both southern Folgefonna).

At Jostedalsbreen, glaciers reached their Little Ice Age (LIA) maximum extent around AD 1750. Nigardsbreen is best documented, where also the advance in the mid-18th century can be quantified. However, the nearby Bergsetbreen shows more distinct glacier advances and retreats since the LIA maximum extent. A minor peak is documented in the 1870s for all outlet glaciers of Jostedalsbreen studied. At southern Folgefonna, the LIA maximum was attained in the late 1870s (second peak around 1890). So far, there is no direct historical evidence for the time before AD 1800.

In a second step, a non-linear back-propagation neural network has been trained with high-resolution multi-proxy reconstructions of temperature and precipitation (input data) and reconstructed glacier length variations (output data). By processing the used climate parameters with a sensitivity analysis based on the neural network we investigate the relative importance of different climate configurations during selected glacier advance and retreat periods. The results confirm the strong influence of (winter) precipitation on glaciers in western Norway. Finally, there is a striking asynchrony between Alpine and Scandinavian glaciers during the LIA and in the 20th century. LIA maximum peaks occurred around 1600/1640 and 1820/1850 in the Alps, and around 1750 (1870–1890) in southern Norway.