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Alpine climate during the Holocene: a comparison between records of glaciers, lake sediments and solar activity

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The understanding of the climate history of the European Alps is crucial, since they are very sensitive and vulnerable to climate change. The recent improvement of Alpine glacier length records and climate reconstructions from annually laminated sediments of Alpine Lake Silvaplana gives the opportunity to investigate the relationship between those two data sets of Alpine climate. Two different time frames are considered: the last 500–1000 years as well as the last 7400 years.

First, we found a good agreement between the two different climate archives during the past millennium: mass accumulation rates (MAR) and biogenic silica (bSi) concentration are largely in phase with the glacier length changes of Mer de Glace and Unterer Grindelwaldgletscher, and the records of glacier length of Grosser Aletschgletscher and
Gornergletscher.

Secondly, the records are compared with temporally highly resolved data of solar activity. We find that the sun has had a major impact on the Alpine climate variations in the long-term, i.e. several centuries to millennia. Solar activity varies with the Hallstatt periodicity of about 2000 years. Hallstatt minima are identified around 500, 2500, and 5000 cal. years BP. Around these times grand solar minima (such as the Maunder Minimum) occurred in clusters coinciding with colder Alpine climate expressed by glacier advances. During the Hallstatt maxima around 0, 2000, and 4500 cal. years BP, the Alpine glaciers generally
retreated, indicating a warmer climate. This is supported by archaeological findings from Schnidejoch, a transalpine pass in Switzerland only accessible when glaciers were retreated. On shorter timescales, however, the influence of the sun cannot be as easily
detected in Alpine climate change, indicating that in addition to solar forcing, volcanic influence and internal climate variations have played an important role.