Alpine glaciers to disappear within decades?

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In densely populated high mountain regions such as the European Alps, glaciers are an inherent component of the Alpine culture, landscape and environment. They represent a unique resource of fresh water for agriculture and industry, an important economic component of tourism and hydro-power production, and a potential source of serious natural hazards. Due to their proximity to the melting point, glaciers are considered among the best natural indicators of global climate change (Haeberli 2004). In this study, glacier inventories, in-situ measurements and a numerical model (based on an empirical relationship between precipitation and temperature at the glacier steady-state equilibrium line altitude) are used in combination with a digital elevation model and GIS techniques to analyse the glacier fluctuations between 1850 and the end of the 21st century of the entire Alpine mountain range.

A complete glacier inventory for the European Alps can be compiled in the 1970s, when approximately 5,150 Alpine glaciers covered a total area of 2,909 km^2. Overall area loss after 1850 amounts to about 35% until the 1970s, and to almost 50% by 2000. Rapidly shrinking glacier areas, spectacular tongue retreats and increasing mass losses are clear signs of the atmospheric warming observed in the Alps during the last 150 years and its acceleration over the past two decades, culminating in an ice loss of another 5–10% of the remaining ice volume during the extraordinary warm year of 2003.

According to the Intergovernmental Panel on Climate Change (IPCC 2001), an increase in summer air temperature of one to five degrees Celsius and a precipitation change between -20% and +30% by the end of the 21st century are plausible scenarios. From the model experiment it is found that a summer temperature rise of 3 °C would reduce the Alpine glacier cover of the reference period (1971–1990) by some 80%, or up to 10% of the glacier extent of 1850. In the event of a 5 °C summer temperature increase, the Alps would become almost completely ice-free. To compensate the change of ±1 °C in 6-month summer temperatures, an annual precipitation increase/decrease of about 25% would be needed.

The present study shows that under such scenarios the probability of Alpine glaciers disappearing within the coming decades is far from slight. With an increase in summer temperature of more than 3 °C, only the largest glaciers, such as the Great Aletsch Glacier, and those on the highest mountain peaks could survive into the 22nd century.

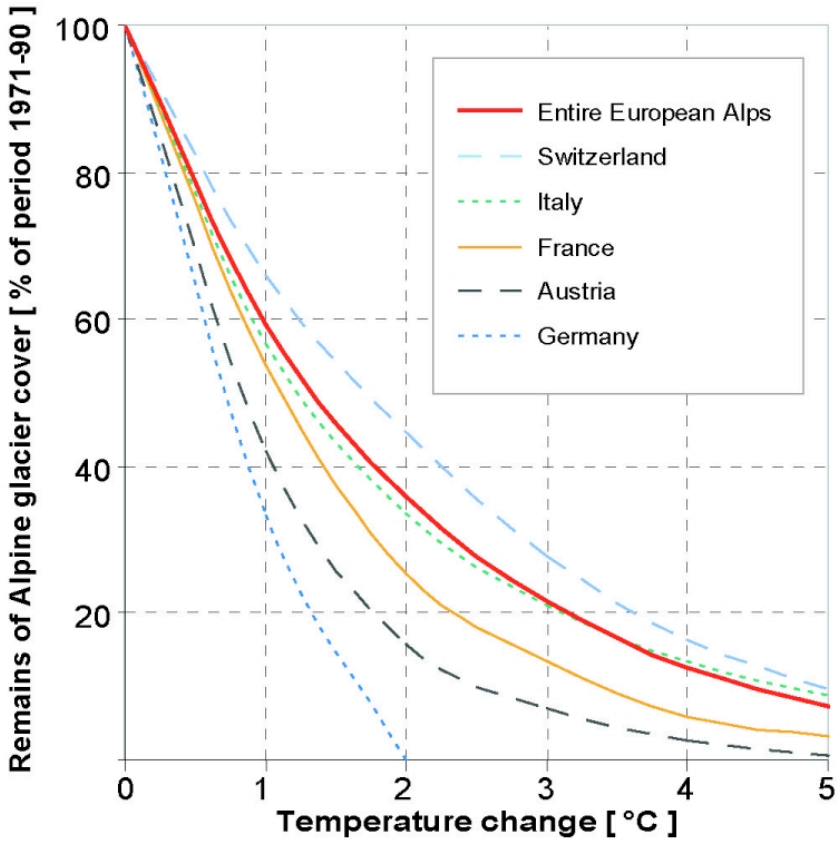

Figure 1. Modelled remains of the Alpine glacierisation (climatic accumulation area) according to an increase in summer air temperature of +1 to +5 °C. The total of 100% refers to the ice cover of the reference period (1971–90). The 100%-marks of the other lines refer to the fraction of glacierisation of the corresponding Alpine country. Reading example: A rise in summer air temperature of 3 °C would reduce the Alpine ice cover (red curve) to about 20% of the glacier cover of the reference period (1971–90). The corresponding glacier remains of Switzerland (blue, dashed line) amounts to about 30%, whereas in Austria (black, dashed line) only about 7% of the glacier cover of the reference period is left.

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