

6.5 Central Europe

Glaciers are found in the European Alps, the Pyrenees, and the Caucasus Mountains. Central Europe has the greatest number available of length change and mass balance measurements, with many long-term data series.



In Central Europe, almost two-thirds of the perennial surface ice cover is located in the Alps with **Aletsch Glacier** as their greatest valley glacier. The Alps represent the 'water tower' of Europe and form the watershed of the Mediterranean Sea, the North Sea/North Atlantic Ocean, and the Black Sea. The highest peak is Mont Blanc, at 4 808 m asl, near the Italian-French border. About one-third of the region's ice cover is represented by glaciers in the Caucasus Mountains which are situated between the Black Sea and the Caspian Sea. Most glaciers are located in the northern part known as the Ciscaucasus with **Mount Elbrus** (5 642 m asl) considered as the highest peak in Europe. Some smaller glaciers are found in the Pyrenees - a mountain range in southwest Europe. It extends from the Bay of Biscay to the Mediterranean Sea. The glaciers are situated in the **Maladeta massif** in Spain with the highest peak of the Pyrenees, Pico d'Aneto (3 404 m asl), and around the peak Vignemale (3 298 m asl) in France. A few more perennial ice fields are found e.g. in the Appennin, Italy, as well as in Slovenia and Poland. In the densely populated Alps, glaciers are a unique resource of freshwater for domestic, agricultural, and industrial use, an important economic component of tourism and hydro-electric power production, but also a source of natural hazards. One of the largest historical glacier disasters occurred in 2002 in North Ossetia, in the Caucasus. An ice-rock avalanche in the



6.5.1 Maladeta Massif

Kazbek region resulting from a slope failure sheared off almost the entire Kolka Glacier and devastated the Genaldon valley, causing the death of about 140 people (Huggel et al. 2005).

In the Alps as well as in the Pyrenees and in the Caucasus most glaciers reached their LIA maximum towards mid 19th century (Gross 1987, Maisch et al. 2000, Grove



Fig. 6.5.2 Mount Elbrus

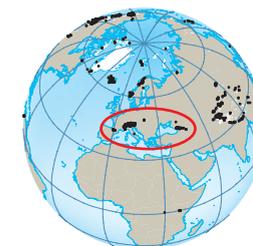
Fig. 6.5.1 Aerial view toward the Maladeta Massif, Spain, with Pico d'Aneto (left), Aneto Glacier (center) as well as Maladeta Glacier (right) from September 2002. Source: M. Arenillas, *Ingeniería 75*, Spain.

Fig. 6.5.2 Mount Elbrus, seen from the north (photograph taken in September 2007). Source: A. Kääh, *University of Oslo*, Norway.

Ice covered area (km²): 3 785

Front variation
 number of series: 764
 average number of observations: 35
 average time length (years): 65

Mass balance
 number of series: 43
 average number of observations: 20



2004). Annual observations of glacier front variations started in the second half of the 19th century in Austria, Switzerland, France and Italy resulting in more than 680 data series, distributed over the entire Alpine mountain range. There are over 40 front variation series available for the Caucasus, mostly starting in the 2nd half of the 20th century and a few going back to the 1930s. There are two glaciers in the Pyrenees with length change data, one starting in the 1980s and a second one covering the 20th century, though with a few observation points. Mass balance measurements started in 1949 in the Alps, in 1968 in the Caucasus, and in 1992 on Maladeta Glacier in the Pyrenees. Overall mass balance data is available for 43 glaciers, with 10 continuous series since 1968.

warm year of 2003 (Zemp et al. 2005). In the Caucasus, glacier retreat since the end of the LIA is also widespread, with a certain amount of mass gain in the late 1980s and the early years of the 21st century. The recent retreat was associated with an increase in debris cover and glacier lake development (Stokes et al. 2007). Since the first half of the 19th century, about two-thirds of the ice cover was lost in the Pyrenees with a marked glacier shrinking after 1980 (Chueca et al. 2005).

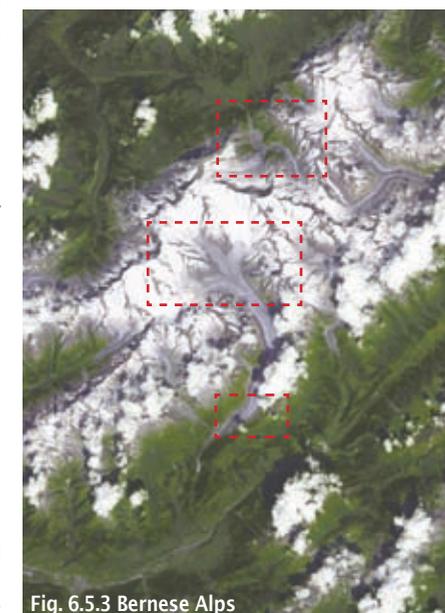


Fig. 6.5.3 Bernese Alps

The front variations show a general trend of glacier retreat over the past 150 years with intermittent Alpine glacier re-advances in the 1890s, 1920s, and 1970-1980s (Patzelt 1985, Pelfini and Smiraglia 1988, Zemp et al. 2007b). The Alpine glacier cover is estimated to have diminished by about 35 per cent from 1850 to the 1970s and another 22 per cent by 2000 (Paul et al. 2004, Zemp et al. 2007b). Mass balance measurements show an accelerated ice loss after 1980 (Vincent 2002, Huss et al. 2008) culminating in an annual loss of 5 to 10 per cent of the remaining ice volume in the extraordinarily



Fig. 6.5.3a

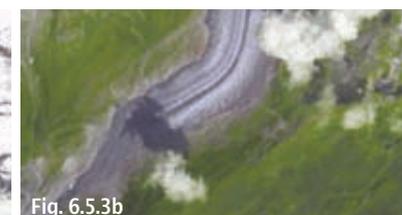


Fig. 6.5.3b



Fig. 6.5.3c