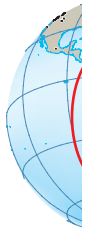
uth America

widespread along the Andes from the tropical ice bodies in the north to the cefields and the Tierra del Fuego in the south. The available fluctuation se- e time period since the 1960s.

Ice covered area (km²):	25 500

Front variation	
number of series:	160
average number of observations:	4
average time length (years):	36

Mass balance	
number of series:	11
average number of observations:	8



The Andes, stretching over 7 000 km, is the world's longest continental mountain range and a distinct feature of South America, forming a continuous chain of mountains in a north-south direction along the entire west coast. In the north-central portion of South America the Andes are divided into several ridges which span some hundred km in width, whereas to the south the Andes form a narrower and more concentrated chain. The highest peak is the Aconcagua (6 962 m asl), situated in Argentina close to the border with Chile. The climate of the Andes varies greatly depending on latitude, altitude and proximity to the sea. This is found for example in the snowline altitude, which is at 4 500 – 4 800 m asl in the tropical Andes of Ecuador, Colombia, Venezuela, and northern Peru, rises to 5 000–6 500 m asl in the Atacama desert (northern Chile), then descends to 4 500 m asl on Aconcagua at 32° S, 2 000 m asl at 40° S, 650–1 000 m asl at 50° S, and only 300 m asl at 55° S (Troll 1973).

Approximate glacier areas for tropical South America are: 1.8 km² for Venezuela, 87 km² for Colombia, 90 km² for Ecuador, 1 780 km² for Peru and 534 km² for Bolivia (Kaser and Osmaston 2002). By far the largest ice cover at about 23 000 km² is found in Chile and Argentina, with more than 85 per cent located in the Northern and Southern Patagonian Icefields and in the Cordillera Darwin Icefield in Tierra del Fuego (Naruse 2006). Glaciers in South America are critically important as a water resource for domestic, agricultural and industrial uses, particularly in equatorial, tropical and subtropical latitudes (Casassa et al. 2007). Andean glaciers also pose a natural hazard, for example, in the form of lahars related to volcanic eruptions, rock/ice avalanches, debris flows and glacier floods related to gravity, climatic processes and ice dynamics (Casassa et al. 2007).

In the southern Andes, most glaciers reached their LIA maximum between the late 17th and early 19th centuries (Villalba 1994). The Peruvian glaciers were in advanced positions in the 1870s, followed by a rapid retreat (Grove 2004). Of the available in-situ mass balance measurements from the Andes only a dozen cover more than a decade, with earliest observations starting at the end of the 1960s. Mass balance is currently being measured on 28 glaciers from which eleven series have been reported. Long-term series comes from Echaurren Norte in central Chile with more than 30 years of continuous mass balance measurements, as well as from Zongo and Chacaltaya in Bolivia (14 years), and Antizana 15 Alpha in Ecuador (11 years). The observations thus include the glacier shrinkage of the past decades. There have been a few cases of surging glaciers, the most recent being Horcones Inferior in Argentina, with two major surge events starting in 1984 and in 2004 (Milana 2007). The small number of available data series indicates the problems encountered when conducting such measurements under difficult logistical conditions and with unreliable financial support (Casassa et al. 2007). Except for a few cases in Patagonia and Tierra del Fuego, glaciers in South America have shown a general retreat and wasting since the LIA maximum extent with an enhanced retreat trend in recent decades (Casassa et al. 2007).


Fig. 6.6.1 Glaciarised volcanoes in Colombia


Fig. 6.6.2 Zongo Glacier

The Northern Patagonian Icefield lost about 3.4 per cent (140 km²) of its area between 1942 and 2001, whereby the frontal tongues of calving glaciers were observed to be an important source of recession and area change (Rivera et al. 2007). Thinning rates of up to 30 m/y have been observed recently in the Southern Patagonian Icefield, with a relevant contribution to sea level rise (Rignot et al. 2003).

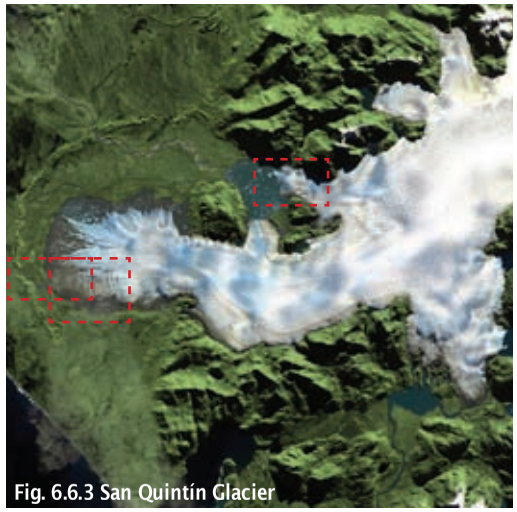


Fig. 6.6.3 San Quintín Glacier

Fig. 6.6.1 Glacierised volcanoes in Colombia. The view to the north shows the active volcanos Nevado del Tolima (foreground) and Nevado del Ruiz (background, right) as well as the the inactive San-

Fig. 6.6.2 Zongo Glacier and downstream hydroelectric power station located north-east of La Paz city, Bolivia. Photograph taken in July 2006. Source: B. Francou, *IRD*, Bolivia.