

the rest of the valley being taken by the tumultuous river of muddy water which escapes from under the melting extremity of the ice. A prolonged augmentation of the snowfall will send the foot of the glacier further down the valley; a diminution of the snowfall or a general rise of temperature will cause it to retreat further up.

Considerable variations in the thickness and length of glaciers have been observed within the last two or three generations, due to oscillations of temperature and wetness. Thus the glacier of La Brenva, on the Italian side of Mont Blanc, shrank to such an extent in the twenty-four years succeeding 1818, that its surface at one place was found to have subsided no less than 300 feet.²²⁹ The glaciers of Mont Blanc had ceased to advance about 1854, and in twelve years, from 1854 to 1865, the Glacier des Bossons had receded 332 metres, that of Bois 188 metres, that of Argentière 181 metres, and that of Tour 520 metres. Similar facts have been observed in the Bernese Oberland and the Tyrol, but with some local exceptions, in particular the Gorner and Aar glaciers.²³⁰ At the Pasterzen glacier, which shrank back about 6 or 8 metres annually, the retreat was changed in 1883 into a forward movement, possibly indicating that the minimum had been reached and that a new advance of the ice had begun.²³¹ Since 1855 the glaciers of the Pyrenees and Caucasus have also shrunk.²³² The glaciers of Greenland and Alaska were formerly much larger than they are now. The Muir glacier in Alaska is said to have retreated half a mile in four years preceding 1890.²³³

In a mountainous region such as the Alps, or a tableland like Scandinavia, where a considerable mass of ground lies above the snow-line, three varieties of glaciers may be observed.

²²⁹ J. D. Forbes, "Travels in the Alps," p. 205.

²³⁰ L. Gruner, *Comptes Rend.* lxxxii. p. 632. *Bull. Soc. Geol. Fran.* iv. (3e ser.). On periodic variations of Alpine Glaciers, see Forel, *Arch. Sci. Bib. Univ. Geneva*, July, 1881.

²³¹ F. Seeland, *Zeitsch. Deutsch-Oesterr. Alpenvereins*, 1884, p. 51.

²³² Ch. Dufour, *Assoc. Française*, 1880, p. 449. The Norwegian glaciers are now retreating.

²³³ H. P. Cushing, *American Geologist*, 1891, p. 215.