

GLACIERS.

1. General Features and Formation of Glaciers.

1. *Nature of glaciers.* — Ordinary glaciers are accumulations of ice of sufficient size to flow down from snow-covered elevations. They are ice-streams, 100 to 1000 feet or more in depth, fed by the snows and hoar frost of extensive areas above the limits of perpetual frost. The half-compacted snow of the source is the *névé* of the Swiss, the *jirn* of the Germans. These fields stretch on from 1000 to 7500 feet below the snow-line, because they are masses of ice so thick that they are not entirely melted during the summer season. Some of them extend down between green hills and blooming banks into open cultivated valleys. The extremities of the glaciers of the Grindelwald and Chamouni valleys lie within a few hundred yards of the gardens and houses of the inhabitants.

Each glacier is the source of a stream made from the melting ice. The sub-glacial stream begins high in the mountains, from the waters that descend through the ice; finally, it gushes forth from its crystal recesses, a full torrent, and hurries along over its stony bed down the valley.

An avalanche is a mass of ice, snow, water, mud, and stones sliding with crashing sounds from some point high up on the side of a mountain; a *glacier* is ice flowing slowly from a perpetual source. Between the two there are small glacier patches, lodged in steep valleys, called *hanging-glaciers* that never move far enough to gain a descent.

As in the case of rivers: (1) glaciers depend for formation and size on the amount of precipitation, and on the size of the drainage area; (2) they take possession of all the valleys of a mountain-region and flow down slopes of all angles; (3) the ice-streams of the upper valleys combine, like so many tributaries, to make the large ice-courses or trunk-glaciers; (4) they suffer loss from evaporation.

But unlike rivers: (1) glaciers require for origin a region extending above the limit of perpetual snow; (2) they require for commencement of flow a large accumulation of the material of a stream; (3) the conditions for increase are best when the yearly precipitation is largely snow. Moreover, (4) the drainage areas are always small compared with those of rivers. The Aletsch, the longest glacier of the Alps, and according to Tyndall the grandest, ends in less than 15 miles; and no glacier outside of Greenland and the Antarctic region exceeds 60 miles in length. Further, (5) they often have confluent heads in a snow and ice region, and may have nearly universal confluence over a continent, as in a Glacial era.

The *limit of perpetual snow*, above which lie the snow-fields of the source, is in general near the line of 32° F. for the mean temperature of the summer. But it varies with the precipitation; for if this is small, the snows of winter may be mostly melted by the heat even of a cool summer, and the limit may be much above the summer line of 32° F., while, on the contrary, if very