Preliminary Theoretical Analysis of Morphologic Features of Alpine Glaciers and Ice Caps

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Massive mountain belts like the Himalayas are home to most modern glaciers outside the Polar Regions. The longitudinal profiles of most major alpine glaciers largely collapse after normalization, indicating that the morphology of alpine glaciers is to a great extent self-formed like the alluvial rivers. The longitudinal thickness profiles of alpine glaciers usually take a prism shape. The thickness is greatest at the boundary between the accumulation zone and the ablation zone and diminishes to zero at the head and the terminus of the glacier. The velocity of glaciers is composed of basal sliding velocity and deformation velocity, both of which are determined by the slope and thickness of glaciers. Field measurement shows that the surface velocity of alpine glaciers is largely uniform in its middle section, and varies not much throughout the entire length. By assuming a uniform surface velocity, a theoretical longitudinal profile was derived which agrees well with the measured longitudinal profiles. It is gentlest at the boundary between the accumulation zone and the ablation zone and steepens in both upstream and downstream directions. Ice caps and ice sheets are glaciers in high-latitude regions that are not constrained by topographical features. They usually take the shape of a shield, which is flat in the middle and steep at the edges. This shape can also be derived analytically by assuming a topographic equilibrium state, i.e. a balance between precipitation and outflow, and relating the velocity of a glacier with its slope and thickness.