



An ALOS-derived glacier inventory of the Bhutan Himalaya

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Glacier inventory provides fundamental information of glacier settings such as number, area, and horizontal/altitudinal distribution, which make possible to study management of water resources, glacial response to climate change, and glacier-related hazards. In the Bhutan Himalaya, heavily debris-covered surface and seasonal snow cover under the humid climate hamper automated mapping of glaciers. We present a novel glacier inventory manually delineated from high resolution (2.5 m) ALOS-PRISM images along the Bhutan Himalaya including Tibetan side. We delineated 1273 glaciers with area of 1408.3 km², in which 210 debris-covered glaciers with area of 951.2 km² were identified.

Scatter plot of top and terminus altitudes of these glaciers shows that the termini of debris-covered glaciers tend to be located at lower altitude than those of debris-free glaciers. Classifying surface aspect into eight directions, surface of the debris-free glaciers tends to be exposed northward (16.7%) while the southwestward surface is minimum (9.2%). No remarkable aspect tendency is found for the debris-covered glaciers. We compare the locations of debris-free glaciers with annual precipitation of TRMM 3B43 data. Median altitude, at which glacier surface is divided into two equal areas obviously increases northward (toward Tibet) along latitude. Additionally the median altitude averaged over basin scale (~2500 km²) shows a significant negative correlation against the annual precipitation ($r = -0.48$, $p < 0.05$). Our results suggest that the high latitudinal gradient of annual precipitation crossing the Bhutan Himalaya contrasts the glacier altitudinal distribution within a scale of 100 km.