Updated Insights on Glacier Surge Mechanisms Inferred from SAR Image Analyses at Two Distinct Settings

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Surge-type glacier exhibits severalfold to orders-of-magnitude speed-up during the short active phase. The faster speed cannot be explained by ice deformation and can only be achieved by basal sliding. Faster basal sliding is attributed to higher basal water pressure, which can reduce the effective overburden pressure and lubricate the interface between the ice and the bed. Two distinct theories have been proposed to explain the generation of high water pressure at Alaskan-type temperate and Svalbard type sub-polar settings, respectively. However, the detailed generation mechanisms remain uncertain at both types of surge because of limited observations.

Here we report spatial-temporal velocity changes of surge-type glaciers at St Elias Mountains in Yukon and West Kunlun Shan in NW Tibet, applying offset-tracking technique to SAR images. At the quiescent surge-type glaciers in Yukon, we detected significant winter speed-up. At the surging glaciers in West Kunlun, we detected seasonal modulations in the velocities, indicating faster speed in winter. These new findings suggest that winter speed-up are never uncommon, and that surface meltwater and its englacial rerouting processes may explain the diversity of glacier surges.

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