

Glacier surge mechanism of Steele Glacier in Yukon, Canada: the 2011-2016 surging episode

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Glacier surge is a periodical orders-of magnitude speed-up event during a short active phase, accompanying terminus advance and ice thickness changes. Near the border of Alaska and Yukon, Canada, there are numerous surge-type glaciers, and their behaviors has received a good deal of scientific attentions. To date, the dynamics have been examined at some surge-type glaciers, but there remain some questions about the generation mechanism.

High-quality images of recent satellites have allowed us to capture the evolutions of surging episodes with high temporal resolution. Steele Glacier in the southwest Yukon is one of the recently activated surge-type glaciers after the quiescence of ~50 years. It experienced the last surge in 1965-1967, and the peak speed was about 24 m/d in early summer 1966 (Stanley, 1969). However, the details of the surging evolution remain unclear. Here we examined the spatial and temporal changes in ice speed, ice thickness and moraines associated with the recent event for the first time in ~50 years.

We used ALOS/PALSAR, Landsat-7, Landsat-8, and Sentinel-1A images to derive the ice speed evolution between 2007 and 2016. Although we have no data in late 2011-early 2013 due to the data availability, RADARSAT-2-based velocity data (Waechter, 2013) showed the latest surge initiated in 2011, and the Sentinel-1A-based velocity data showed it terminated in fall 2016. The observed maximum speed was greater than 20 m d⁻¹ in early summer 2015, whereas the quiescent speed was ~0.4 m d⁻¹ between 2007 and 2011. The rapid acceleration changed the ice thickness, which is revealed by Terra/ASTER DEMs. In 2006-2011, the ice thickened above the confluence. In 2013-2016, the ice thickened in the middle and downstream region, while it thinned above the confluence.

Based on the ice thickness changes and the moraine movements, the surge started at the confluence of Hodgson and Steele Glaciers. We will discuss the surge mechanism based on the diverse datasets.

Keywords: Glacier surge, ALOS/PALSAR, Landsat, Sentinel-1