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Winter acceleration of the glacier flow in Yukon territory: detection and interpretation

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We examined spatial and temporal changes of the glacier surface velocities at Yukon territory, applying offset-tracking technique to the synthetic aperture radar (SAR) imageries. The SAR images we used are mostly derived from Phased Array-type L-band SAR (PALSAR) sensor on the Advanced Land Observation Satellite (ALOS) launched by JAXA in 2006.

We discovered that many glaciers revealed acceleration signals in winter. No similar signals have been reported so far, and are counter-intuitive in comparison to the well-known spring/summer speed-up signals at many other glaciers in the world. The winter acceleration signals are thus intriguing and could have important implications for the dynamics of surge-type glaciers. Thus, we discuss a possible interpretation for the signal on the basis of field-based studies at Trapridge glacier, Yukon.

Kavanaugh (2009) performed in-situ water pressure change measurements at Trapridge Glacier, and reported that pressure pulse events increased from autumn to winter during 2005-2006. He interpreted this signals resulted from episodic basal motion caused by the till deformations that follows Coulomb-plastic rheology, in which the strain rate increases infinitely when shear stress exceeds the yield stress (Kavanaugh and Clarke, 2006). The yield stress depends linearly on the effective pressure that can vary seasonally. If we follow Kavanaugh's observation and interpretation, we may regard our observed winter acceleration signals as the episodic sediment deformations that occurs more frequently in winter. From summer to winter, the surface-melt water is reduced, and the drainage systems will gradually evolve from efficient well-connected to inefficient ill-connected drainage system. Then, basal water pressure will become locally higher and the yield stress in the sediment get smaller, which could generate more frequent till deformation in winter.

It is known that glacier surges tend to occur from autumn to winter. Our discovery has the probability mini-surges occurred every year. More frequently observations in winter season could be a key to reveal surge generation mechanisms.

Keywords: winter acceleration, Yukon, surge-type glaciers, SAR, offset tracking