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Surface velocity and its dynamics mechanisms of Baltoro glacier, Karakoram

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Introduction: As global warming intensifies, most of mountain glaciers are in retreat in the worldwide. However, glaciers in Karakoram have been observed to be thickening and advancing. Baltoro Glacier, one of the longest Asian glaciers, is located in the central Karakoram. It extends over a distance of 66km from the western face of K2 (8611m a.s.l.) to the glacier snout with an elevation of $\sim$ 3500m. Therefore, it has a great significance to monitor and detect surface motion of the Baltoro glacier for understanding characteristics of glacier dynamics in the central Karakoram.

Data and methods: Three of ENVISAT ASAR images acquired during the period 2004-2006 were used for this study. The acquisition times of the SAR images are respectively 6 August 2004, 26 August 2005 and 11 August 2006. These images have spatial resolutions of 20-30m in ground range at scene center. In order to ensure the minimum spatial baseline and consistent imaging conditions, all data are selected with the same orbit. In this study, the SRTM-C DEM is also used to geocode the ENVISAT ASAR images.

Glacier surface velocity is derived from the offset tracking method which is widely used to estimate surface displacements. This method relies on identifying surface features across two time-separated synthetic aperture radar (SAR) scenes. Intensity tracking and coherence tracking are often used. In this study, we use the intensity tracking due to the low coherence of ENVISAT ASAR data pairs with 1 year apart. The offset fields are generated with a normalized cross-correlation of image patches of detected real-valued SAR intensity images. The processing consists of four steps: (1) Determination of the orbital offset between the two SAR SLC images. (2) Precise estimation of the offsets using intensity cross-correlation. (3) Computation of the offsets of two ASAR images in range and azimuth directions. (4) The offsets in range and azimuth directions are then transformed to surface displacements.

Results and Conclusions: The surface velocities of the Baltoro glacier are estimated, and the results indicate that the glacier is relatively stable during 2004 to 2006. Moreover, the ice motions have different dynamics mechanisms at terminus and upper of the Baltoro glacier. On the upper area, the surface velocities are relatively high, and their transverse profiles show that the velocity are constant on the glacier center but reduce rapidly close to the margins. It infers that glacier motion of this area is controlled by a basal-sliding mechanism. By contrast, the velocities at the terminus are generally low and increase gradually from the margins to the glacier center. That means that ice-motion is a more dominant motion mechanism at the terminus.