DERIVATION OF GLACIER VELOCITY FROM SAR AND OPTICAL DATA WITH FEATURE TRACKING

Lei Huang[1,2] *Zhen Li*[1]
[1]Center for Earth Observation & Digital Earth, Chinese Academy of Sciences, China
[2]Graduate School of Chinese Academy of Sciences, China
E-Mail: hlhjsx@126.com

1. INTRODUCTION

Glaciers and ice caps provide among the most visible indications of the effects of climate change [1]. However, the temporal sparsity of velocity data has made it difficult to explain the nature of the relationships between thinning, acceleration and retreat in these glaciers.

There are three ways to determine glacier velocity: DGPS (Differential Global Positioning System), InSAR (Synthetic Aperture Radar Interferometry), and feature tracking. The first two methods are the most accurate, but DGPS is impossible to be widely used in large areas and InSAR is usually limited by decorrelation in mountainous terrain [2]. The big advantage of feature tracking is that it is not influenced by coherence. Optical and SAR images are both available for this method and they are complementary. Optical images provide high quality of glacier surface features while SAR images have the ability of penetration of snow and cloud.

In this paper we derive glacier velocities from ALOS optical and SAR images respectively with feature tracking. Advantages, applicable conditions, accuracy and demerit of the two kinds of data about feature tracking method are discussed. We also developed a new method to determine the best size of grid in correlation calculation of feature tracking. Another improvement is made for noise filtering in flow field.

2. METHOD

Feature tracking in SAR imagery is similar to optical imagery. In this method, two coregistered satellite images of different times are employed. The first image (called master image) is divided into grid and each square searches for its counterpart square in the second image (called slavery image) according to correlation coefficient. Move velocity can be calculated given the temporal separation and the measured displacement.

The size of grid is a significant parameter in calculating offset of images, and different grid size usually leads to different offset and further results in different flow velocity. Our research tries to find out moderate grid size to provide glacier velocity with the best precision.

The research is based on the hypothesis that velocities of one glacier change gradually on a large scale. According to mass balance, it is unreasonable if an individual square has much higher or lower velocity than its adjacent squares around. Special cases may exist in small areas with steep terrain, but the continuity is a basic principal on a large scale. AVG, which is defined as averaged velocity gradient, is employed. AVG is a measure of averaged velocity differences between adjacent squares in acquired velocity map, and it will be described in details in the paper. AVG is in high value while grid size is small and AVG decreases abruptly while grid size grows. While grid size grows to some extent, the change of AVG becomes gentle. We pick the grid size on turning point that AVG curves shifts from abrupt to gentle as the size of optimal grid. Flow field calculated with the best size grid gets a balance between AVG value and plane resolution of velocity map.

Besides moving, other variations also exist on glaciers, such as melting, rocks rolling. Mismatches resulted from these variations are inevitable, and they are treated as noise on velocity map. Noises are filtered out with our method considering velocity difference of one square and its ambient ones. While the difference exceeds a threshold the velocity will be filtered out as noise and the gaps will be filled by linear interpolation.

3. EXPERIMENTS

Keqicar Baxi Glacier lying in Chinese west Tienshan Mountain is picked out as study area. One of the distinct characteristics of this glacier is the presence of debris covering a large portion of the ablation zone. The images employed in this paper are all from ALOS optical (PRISM) and SAR (PALSAR) data. The glacier above 3600 m a.s.l is covered by snow, so only the lower part of the glacier (from 3600 m a.s.l to the terminus) is available for optical image. The glacier between 4000 m a.s.l and the terminus is available for SAR images. Velocity maps are shown in figure 1.

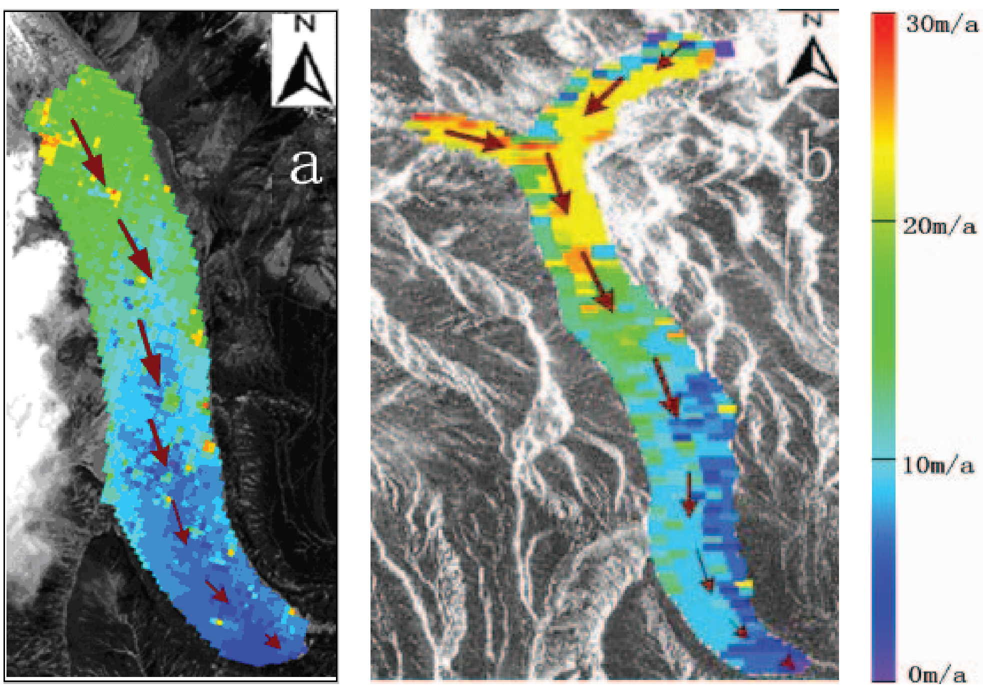

Figure 1. (a) Velocity map of the Keqicar glacier from 3600 m a.s.l to terminus acquired from optical images
(b) Velocity map of the Keqicarfrom SAR image from 4000 m a.s.l to terminus acquired from SAR images

4. REFERENCES

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