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Long-term change in ice velocity of Urumqi Glacier No. 1, Tian Shan, China

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Abstract Glacier flow velocity of Urumqi Glacier No. 1 has been continuously measured at the end of every summer since 1980. The observation results show that the average surface velocity was 5.5 m a^{-1}, 4.6 m a^{-1}, 3.8 m a^{-1}, and 3.3 m a^{-1} in 1980/1981, 1990/1991, 2000/2001, and 2010/2011, respectively. The annual average velocity was reduced by 1.3% a^{-1} from 1980/1981 to 2011/2012. The climate change is the essential cause for long term velocity change because continuous mass loss or gain will result in ice thickness decrease or increase. A suddenly sharp change in the mass balance could lead to a short change in velocity. Long term change in the velocity can be analyzed by glacial dynamic model. Using the simplified equations, analysis of the surface velocity along the centerline shows that influence of the ice thickness change is most important and could be modeled well. The velocity is very sensitive to the surface slope change but the validity of its effect modeling is relatively low due to the large spatial variability of surface slope. Under the combination effect of decrease in both ice thickness and surface slope, the velocity of the West Branch has a relative large decrease. The calculated decrease in surface velocity along the centerline is 3.8 m a^{-1} from 1981 to 2012, relatively close to the value of 3.6 m a^{-1} from observation. Increase in surface slope of the East Branch has an offsetting effect on ice thickness decrease. To further analysis, besides more data, a better model is needed to describe physical and dynamic processes.

Key words: ice velocity; glacier change; ice thickness; surface slope; Urumqi Glacier No. 1; Tian Shan

1. Introduction

It is well known that the widespread mountain glaciers conserve huge fresh water and hence their changes have vital impacts on regional water resource and economic society besides sea level (Arendt et al., 2012; IPCC, 2013; Vaughan et al., 2013; Zemp et al., 2015; Li et al., 2016). With the global warming increasing, almost all glaciers world-wide have continued to shrink as revealed by the time series of measured changes in glacier length, area, volume and mass since the middle of the