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Seasonal and annual variations of mountain glaciers surface velocity, implications for ice dynamic. Case study: Karakorum and Pamir.

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The Pamir and Karakorum regions are heavily glaciated and contain some of the largest and fastest mountain glaciers on Earth. Satellite imagery is key to constrain ice dynamics, in particular glacier surface velocities, and sub glacial processes, e.g., basal sliding or glacier erosion, in such large and remote regions. Significant velocity variations have previously been observed in this area and related to forcing by seasonal meltwater and surges mechanisms. However, the details of surges sequences, in particular their initiation and termination, and multiyear seasonal patterns are still poorly documented. Here we study 26 glaciers and quantify surface velocity variations at high temporal resolution from remote sensing. We present a processing strategy to exploit the large archives of optical satellite imagery available for the study area to obtain more than 500 velocity fields with a 16-day temporal resolution from April 2013 to July 2016. Glacier displacement is measured with a 1.5-meter resolution using sub-pixel correlation (COSI-Corr software) of Landsat-8 images. 14 out of the 26 studied glaciers show seasonal velocity variations with inter-annual variability. These glaciers typically accelerate in early spring, up to 150% of the winter velocity, starting in the ablation zone and occasionally propagating upstream. This behaviour supports a meteorological/hydrological forcing with higher velocities caused by an increase in water pressure due to melt water input during spring time. 12 out of the 26 glaciers underwent one sub-annual or multiyear surging event during the study period. The surging events do not follow a unique pattern. Velocity can increase by up 700% over a month, and with an acceleration that initiate anytime of the year. This suggests that surges are initiated by an internal process, e.g., shear heating or basal hydrology, rather than by an external seasonal forcing.