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Mass changes of glaciers over the Central Karakoram derived from TanDEM-X and SRTM/X-SAR Digital Elevation Models

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Snow cover and glaciers in the Karakoram region are important freshwater resources for many downriver communities as they provide water for irrigation and hydro power. A better understanding of current glacier changes is hence an important baseline information. Glaciers in the Karakoram have shown stable and positive glacier mass balances during recent years as well as stable and advancing termini positions. The Karakoram is also known for a large number of surge-type glaciers.

Here, we present geodetic glacier elevation and mass changes using TanDEM-X and SRTM/X-SAR Digital Elevation Models between 2000 and 2012. Based on previous glacier inventories for the Karakoram, we show elevation changes and glacier mass balances for glaciers with advancing and stable termini between 2000 and 2012 as well as surge-type glaciers separately. In order to convert volume changes to mass changes, we applied different density scenarios (i.e., constant densities for ice and snow or zonally variable densities).

Our findings show average glacier thickening of +0.01 $\pm$ 0.02 m a^{-1} or mass gain of +0.0099 $\pm$ 2.8x10^{-5} Gt a^{-1}(using a density of 850 kg m^{-3}) between 2000 and 2012 for parts of the Central Karakoram. Surge-type glaciers and advancing glaciers indicated slight surface lowering, while the majority of the studied glaciers showed stable termini and surface thickening. Our measurements are independent from varying penetration depths of the radar signal or temporal decorrelation between image acquisitions. Both datasets were acquired in the X-band frequency under assumed similar surface conditions. The bistatic TanDEM-X mission is highly suitable for interferometric processing due to high spatial resolutions and only 3 sec time lag between TanDEM-X and TerraSAR-X overpasses. We want to stress the enormous potential of the TanDEM-X mission to estimate geodetic glacier mass balances, in particular when compared to elevation data sets acquired in a similar frequency and comparable observation period.