



Seasonal changes of surface velocity and elevation of Columbia Glacier, Alaska using time-series TerraSAR-X/TanDEM-X data

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Alaskan glaciers are a major contributor to global sea-level rise from glaciers and ice caps outside the polar ice sheets. Columbia Glacier is a large tidewater glacier located on the coast of south-central Alaska. The glacier has retreated ~ 21 km and lost half of its volume during 1957-2007, more rapidly after 1980. It is now split into two branches, known as Main/East and West branch.

In this study, we used time series of high-resolution TerraSAR-X/TanDEM-X stripmap satellite imagery during 2011-2014 to investigate the temporal development of glacier surface velocities, elevation and mass changes. The active SLC images of the bistatic TanDEM-X acquisitions, acquired over 11 or 22 days repeat intervals, are utilized to derive surface velocity fields using SAR intensity offset tracking. We observed a very strong seasonal variability in the surface velocities. Maximum values at the ice front reach up to 14.43 m/day in May and reduced to 2 m/day in October in the year 2012. However, at a distance of 17.5 km from the ice front, almost no seasonal variability can be observed. A significant influence in the distance to the terminus and elevation was detected. We attributed this temporal and spatial variability of surface velocity to changes in the basal hydrology and lubrication of the glacier bed. Similar fluctuations are observed in consecutive years.

In a second step, we exploited TanDEM-X data by interferometrically generating time series of digital elevation models (DEMs). For quantitative volume change estimates, we used DEMs of almost similar months of the observational years in order to minimize errors resulting from variable X-band radar penetration. The main branch gained a volume of $12.77 \pm 2.89 \text{ km}^3$ in 2011-12, but lost $-18.94 \pm 3.21 \text{ km}^3$ in 2012-13. A slight gain was observed with $1.05 \pm .88 \text{ km}^3$ in 2013-14. However, the west branch gained volume only in 2011-12 and lost in the consecutive years. Moreover, the west branch retreated by ~ 3 km and lost its area twice faster than the main branch during 2011-14.