Surface elevation change of outlet glaciers in northwestern Greenland

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Ice discharge from calving glaciers has been increasing in the Greenland ice sheet (GrIS) since 2000s. This increase plays important roles in the volume change of GrIS and its contribution to sea level rise. To investigate the mass loss of GrIS calving glaciers, ice surface elevation change has been studied by differencing digital elevation models (DEMs) derived by satellite remote-sensing. Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) images of Advanced Land Observing Satellite (ALOS) have a spatial resolution of 2.5 m, which is fine enough to measure several meters of elevation change on glaciers. The large spatial coverage of the images (1225 km^2) is suitable for studying glaciers distributed over a large area.

In this study, we measured surface elevation change of 14 outlet glaciers near Inglefield Bredning in northwestern Greenland (77°47′–78°10′N, 65°00′–72°47′W). These glaciers flow into the ocean except for two land-terminating glaciers. We processed stereo pair ALOS PRISM images acquired in summer 2007 and 2010 with a digital map plotting instrument (Leica Photogrammetry Suite) to generate DEMs with a 25 m grid mesh. Elevation data from ALOS DEMs were calibrated on ice-free terrain, and compared to calculate ice surface elevation change between 2007 and 2010.

The surface elevation of all the studied glaciers decreased and the magnitude of the elevation change increases downglacier. The mean elevation change rate ranged from −0.4 to −4.9 m a^{-1}. Marine-terminating Tracy and Bowdoin Glaciers thinned at rates of −4.9 and −4.1 m a^{-1}, which were larger than those at other glaciers. The rate at Tugto Glacier, a land-terminating glacier located near Bowdoin Glacier, was −2.8 m a^{-1}. This result confirms that recent thinning of GrIS outlet glaciers is more significant at marine-terminating glaciers as compared to land-terminating glaciers. Rapid thinning of marine-terminating outlet glaciers observed in this study suggests the importance of ice dynamics and/or ice-ocean interaction in the mass loss of GrIS.

Keywords: Arctic glaciology, Glacier thinning, Glacier dynamics

