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Calving Front Dynamics and the drive mechanisms of Jakobshavn Glacier in recent 30 years

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Greenland glaciers are sensitive indicators of climate change and play important roles in the contribution of global sea level rising. Jakobshavn Glacier (JG) is one of the most active glaciers around the world with the discharge of more than 35km3 of ice every year. In this study, dozens of Landsat images during 1986-2016 were used to extract the calving fronts of JG by visual interpretation. ERA-Interim data from ECMWF were used for estimating the energy balance budget and computing the melt at the surface and the bottom of JG during 1980-2016. Temperature and net radiation observations during 2008-2015 in the summer were collected to validate the reanalysis data. Ice velocity data acquired from NSIDC were involved to discuss the dynamics driving mechanisms. JG retreated by over 15 km during 1986-2016 and the retreat experienced three distinct stages. It retreated slightly in the first stage with a rate of 66.13 m/yr during 1986-1997. The rapid retreat happened in the period from 1998 to 2016, with a retreat rate of 1337.6 m/yr. In the third stage, the glacier achieved a steady state with a low retreat rate of 18.08 m/yr. Then, the distributed energy balance function is used to estimate the energy balance of surface and bottom of JG by using reanalysis data such as net radiation, sensible heat flux and heat from precipitation. The result shows that the available energy for thaw at the bottom of JG was 500 W/m2 on average which was about three times more than the energy at the surface of JG. Bottom thaw of JG provided more contribution for thinning the glacier than surface thaw. The surface elevation of JG decreased before the rapid retreat of the calving front. Concurrent with the 1998-2010 rapid front retreat, the ice velocity near the calving front accelerated. All results implicated the possible drive mechanism of JG's calving front dynamics. The thinning of the calving front led to large calving events which was responsible on the rapid retreat. The calved front of glacier remained in the fjord and accumulated. Then ice mélange were generated. Since ice mélange increased the support, the ice velocity of the glacier slowed down and JG became relatively stable.