グリーンランド北西部における海洋性溢流氷河の末端位置と流動速度の季節変化

Seasonal variations in frontal positions and flow speeds of marine terminating outlet glaciers in northwestern Greenland

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Greenland ice sheet is losing mass due to increase in surface melting and ice discharge from marine terminating outlet glaciers. The mass loss from the Greenland ice sheet accounts for a substantial part of global sea level rise over the last several decades. To accurately include the contribution of marine terminating outlet glaciers in the future projection of global sea level rise, better understanding of mechanisms controlling the glacier dynamics is required. Thus, it is important to study changes of marine terminating outlet glaciers in connection with atmospheric and the ocean conditions. For this purpose, we analysed Landsat images to measure frontal positions and flow speeds of marine terminating outlet glaciers along the coast of the Prudhoe Land, northwestern Greenland between 1987 and 2015. Relationships among frontal position, flow speed, sea ice condition in front of glacier terminus, and air temperature were investigated with special focus on seasonal variations.
All of studied 19 glaciers retreated from the 1980s to 2014. Among those, Heilprin, Tracy, Farquhar, Melville, Bowdoin, and Diebitsch Glaciers retreated by more than 1 km. Most of the studied glaciers began retreat around 2000, as demonstrated by the increase in the mean retreat rate from −1 m a^{-1} in 1980s–1999 to 66 m a^{-1} in 2000–2014. A possible driver of the rapid retreat since 2000 is atmospheric warming because the rapid retreat followed the onset of summer temperature increase in northwestern Greenland. Within 5 km from the studied fronts, ice speed ranged between 14 and 1814 m a^{-1}. Many of the studied glaciers accelerated in the early 2000s. Magnitude of the acceleration was correlated with the retreat rate as demonstrated by rapid retreat and flow acceleration at Heilprin, Tracy, Farquhar, Bowdoin and Diebitsch Glaciers. The acceleration was greater near the front, suggesting the change in the flow regime enhanced stretching of ice along the glacier and induced dynamic thinning. These results indicate that ice thinning due to flow acceleration was the driver of the rapid frontal retreat of the sutdied glaciers.
In general, studied glaciers advanced from spring to early summer, which was followed by retreat in late summer. Then, the front stayed at the retreated positions throughout the following fall. Magnitude of the seasonal front variations ranged in 50–400 m. The timing of the seasonal retreat agreed with the disappearance of sea ice in front of the glacier terminus. Many of the glaciers indicated speedup from spring to mid-summer and deceleration in late summer. Magnitude of the seasonal variations in ice speed was between 80 and 440 m a^{-1}. Because the speed changes were correlated with air temperature in summer season, the seasonal speedups were probably due to enhanced basal sliding driven by meltwater input to the bed.

キーワード：氷河、グリーンランド
Keywords: Glacier, Greenland