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Seasonal flow speed variations of marine-terminating outlet glaciers in northwestern Greenland

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The Greenland ice sheet is losing mass under the influence of increases in surface melting and ice discharge from marine-terminating outlet glaciers. To project changes of the ice sheet under the changing climate, better understanding of the dynamics of marine-terminating outlet glaciers is required. To this end, we studied seasonal flow speed variations of 10 marine-terminating outlet glaciers along the coast of the Prudhoe Land, northwestern Greenland. Surface speed near the glacier front was measured using Landsat 8 images taken from 2014 to 2016. We obtained 18–28 speed data for each month from March to September. Area covered by supraglacial ponds and meltwater plume in front of the glacier were mapped by analyzing the Landsat images. Flow speed variations were compared with the ice front positions, sea ice condition near the termini, air temperature, area of supraglacial ponds and meltwater plume to investigate the driver of the seasonal changes in the ice dynamics.
All of the study glaciers accelerated from May/June to June/July, and then slowed down from July to September. Magnitude of the speedups ranged between 120 and 680 m a^{-1}. In early summer, flow speed increased as air temperature rose up and the area of supraglacial ponds expanded. These observations suggest that the seasonal speedup was caused by meltwater input to the glacier bed. Flow speed dropped when annual sum of the positive-degree day reached $\sim$100 K d, supraglacial water drained and meltwater plume appeared. These changes occurred before air temperature reached the summer maximum. Our interpretation of the glacier deceleration is that subglacial drainage system had developed because of the drainage of supraglacial ponds which lead to the drop in the subglacial water pressure. Our study demonstrated that the rate of meltwater production controls the seasonal acceleration, and the drainage of supraglacial ponds triggers the later deceleration.