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Seasonal evolution of subglacial drainage and acceleration in a Greenland outlet glacier

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The Greenland Ice Sheet (GrIS) contains 7m of potential eustatic sea level rise yet its present mass balance and future contribution to sea level is poorly constrained (IPCC, 2007). Recent observations indicate that mass loss near the margin is accelerating, in part the result of increases in ice motion. Surface meltwaters are known to access the ice sheet base and affect ice motion through the lubrication of basal flow. However, the ice-motion response to seasonal variations in meltwater inputs remains poorly constrained both spatially and temporally. Here, we present ice motion data from GPS sensors located along a $\sim$100 km transect at the western margin of the GrIS. Our sensors reveal substantial increases in summer motion, of up to 250%, compared with winter background. These motion variations display an upglacier evolution over the course of the summer, with initial velocity enhancement occurring earlier at sites close to the ice margin. The pattern of ice motion and hydrological characteristics of the proglacial runoff suggests a seasonal evolution in the subglacial drainage system similar to hydraulic-ice dynamic forcing mechanisms observed at smaller valley glaciers. Our findings show that the relationship between melt and ice motion varies both at-a-site and between sites during the melt season. This variability must be incorporated into ice-sheet models to improve future predictions of ice-mass change.