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Tidewater dynamics at Store Glacier, West Greenland from daily repeat UAV surveys

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A significant component of the Greenland ice sheet's mass wasteage to sea level rise is attributed to the acceleration and dynamic thinning at its tidewater margins. To improve understanding of the rapid mass loss processes occurring at large tidewater glaciers, we conducted a suite of daily repeat aerial surveys across the terminus of Store Glacier, a large outlet draining the western Greenland Ice Sheet, from May to July 2014 (https://www.youtube.com/watch?v=-y8kauAVAfE). The unmanned aerial vehicles (UAVs) were equipped with digital cameras, which, in combination with onboard GPS, enabled production of high spatial resolution orthophotos and digital elevation models (DEMs) using standard structure-from-motion techniques. These data provide insight into the short-term dynamics of Store Glacier surrounding the break-up of the sea-ice mélange that occurred between 4 and 7 June. Feature tracking of the orthophotos reveals that mean speed of the terminus is 16 - 18 m per day, which was independently verified against a high temporal resolution time-series derived from an expendable/telemetric GPS deployed at the terminus. Differencing the surface area of successive orthophotos enable quantification of daily calving rates, which significantly increase just after melange break-up. Likewise, by differencing bulk freeboard volume of icebergs through time we could also constrain the magnitude and variation of submarine melt. We calculate a mean submarine melt rate of 0.18 m per day throughout the spring period with relatively little supraglacial runoff and no active meltwater plumes to stimulate fjord circulation and upwelling of deeper, warmer water masses. Finally, we relate calving rates to the zonation and depth of water-filled crevasses, which were prominent across parts of the terminus from June onwards.