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Velocity Patterns Across the Kaskawulsh Glacier, Yukon Territory, Canada

Samantha Darling (1), Luke Copland (2), Laurence Gray (3), and Wesley Van Wychen (4)

(1) Laboratory for Cryospheric Research, University of Ottawa, Ottawa, Canada (samantha.j.darling@gmail.com), (2) Laboratory for Cryospheric Research, University of Ottawa, Ottawa, Canada (luke.copland@uottawa.ca), (3) Laboratory for Cryospheric Research, University of Ottawa, Ottawa, Canada (laurence.gray@sympatico.ca, (4) Laboratory for Cryospheric Research, University of Ottawa, Ottawa, Canada (wvanw046@uottawa.ca)

Laser altimetry and satellite gravity surveys indicate that the St Elias Icefields are currently losing mass and are among the largest non-polar sea level contributors in the world. A poor understanding of glacier dynamics in this region is a major hurdle in determining regional ice fluxes and evaluating regional and local variations in ice motion and the relationship to changing surface conditions. This study combines in-situ dGPS measurements and advanced RadarSAT-2 (RS-2) processing techniques to determine seasonal and daily ice velocities for the Kaskawulsh Glacier. Speckle tracking works primarily in winter, when ground response remains relatively unchanging. The dGPS measurements are collected year-round, so provide a method for validating the RS-2 winter velocities, as well as providing information about summer velocity patterns. A network of three permanent dGPS stations were installed along the centerline of the glacier in 2009, and expanded in 2010 with an additional permanent station and two summer stations, along with temperature sensors on the permanent stations and snow depth sounders. Daily winter values and continuous summer values were collected and downloaded monthly during the summer of 2010.

Preliminary analysis of the dGPS observations shows consistent patterns across the glacier, with averages of 105 m yr^{-1} at the terminus at (1154 m asl), 131 m yr^{-1} at the middle of the ablation area (1574 m asl), and 144 m yr^{-1} just below the equilibrium line (1755 m asl). Most notably, there was a rapid but short acceleration over a period of five days peaking on February 19, 2010, with velocities at the equilibrium line up to 325m yr^{-1} followed by a decrease in velocity to 120 m yr^{-1}. Similar differences were found in the middle and terminus stations. RS-2 imagery was acquired on a 24-day cycle in the winters of 2010 and 2011 in both ultrafine and fine beam modes. This data was processed for velocities with a speckle tracking algorithm which uses a cross-correlation method to determine displacement from the returned phase information. A DEM from Geomatics Yukon is used to remove the effects of differences in range on true displacements. Calculated velocities along the glacier for January-February 2010 at station sites were comparable to dGPS observations (terminus: 147.8 m yr^{-1} calculated, 106.1 m yr^{-1} observed; middle of ablation area: 122.1 m yr^{-1} calculated, 129.1 m yr^{-1} observed; equilibrium line: 153.8 m yr^{-1} calculated, 144.2 m yr^{-1} observed). These particular results show an average error of 19.1 m yr^{-1}, indicating the feasibility of on-site dGPS as a validation tool for RS-2 techniques.