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Feature tracking of sub-metre resolution Capella SAR imagery to measure mountain glacier ice flow

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In recent years, the number and capability of Synthetic Aperture Radar (SAR) sensors in low earth orbit has grown considerably, with multiple satellites now capable of capturing sub-metre resolution imagery. We present the first application of such very fine resolution SAR imagery to measure ice velocity of a high mountain glacier. To achieve this, we apply feature tracking to a pair of Capella images in spotlight mode (0.35 m resolution) acquired in July 2021 over Baltoro Glacier in the Karakoram, Pakistan, and compare the results to ice velocities derived from feature tracking using more commonly employed TerraSAR-X Stripmap (3 m) and Sentinel-1 Interferometric Wide (IW) (5 x 20 m) imagery. We show that Capella-derived velocities reveal subtle features that are not evident in velocities derived using coarser resolution imagery. In particular, slower moving ice at the glacier margin, variations in velocity between different flow units, and lateral fluctuations reflecting the local topography are all more clearly resolved. However, the small footprint of the imagery and lack of stable ground within the frame poses a challenge for co-registration which could affect the feasibility of broad-scale applications. Despite this, we show that sub-metre resolution SAR imagery enables us to observe and analyse glacier dynamics at temporal and spatial resolutions that were previously impossible using satellite-based methods. We suggest that such imagery may be used alongside in-situ methods to improve our understanding of fine-scale glaciological processes which may have a significant impact on broader scale glaciological systems.