Integration of Altimeter Data from ICESat, IceBridge, CyroSat-2 and ICESat-2 --- Mathematical Approaches and Applications to Glacial Change

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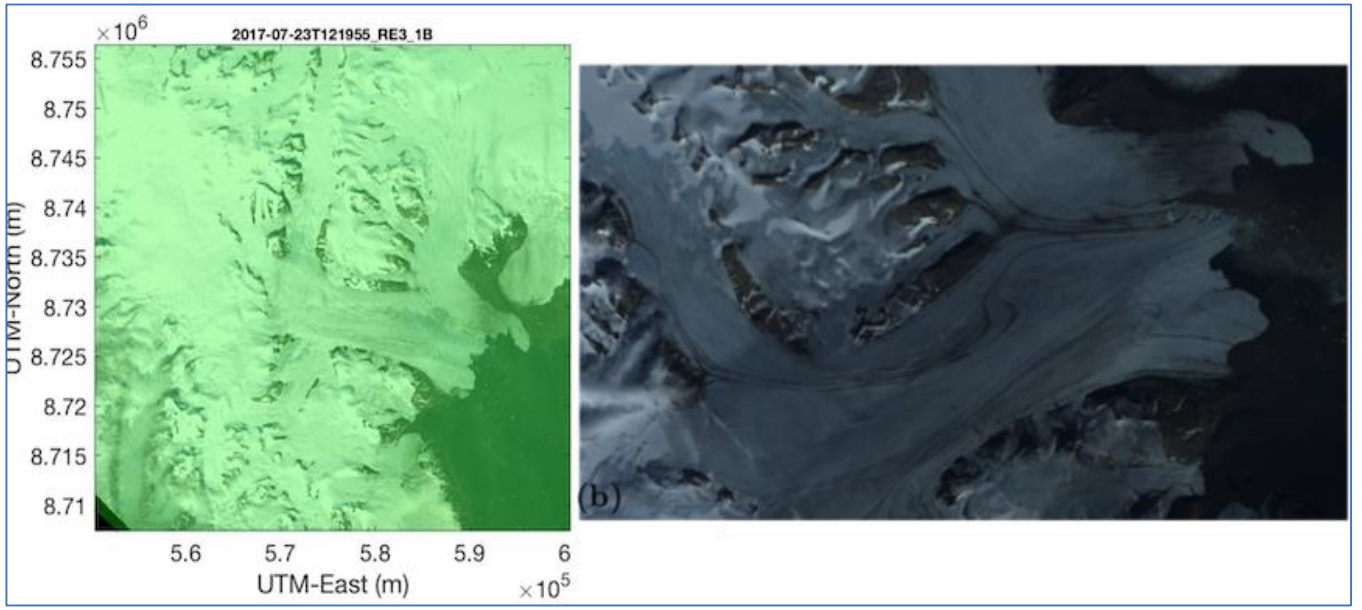
Purpose: Study of glacial acceleration

Study Objective: Use the imagery from commercial satellites to observe and analyze glacial acceleration. Our approach employs ice-surface roughness and crevassing to derive numerical characteristics and classifications of fast-moving and surging glaciers. Results aid in ice-dynamic modeling and constraining uncertainties of mass balance and sea-level change

Imagery: WorldView; PlanetScope Dove, RapidEye, SkySat

Findings: RapidEye imagery was successfully used to derive characteristics of heavy crevassing, here quantified by the surface roughness parameter (pond), a manifestation of rapid glacial acceleration. The larger area imaged by RapidEye helped mitigate problems associated with combining smaller images. Its spatial resolution is a substantial improvement over imagery provided by Landsat-8, allowing for a more detailed assessment of surface roughness. SkySat's higher resolution facilitates classification of several crevasse types, but has very small scenes and some mismatch of radiometric properties across sensors carried on different satellites. The imagery suffers from poor cloud screening over ice and snow (Dove, RapidEye and SkySat), lacks rigorous satellite intercalibration (Dove & SkySat), has insufficient radiometric resolution (Dove) and accurate geolocation. Data are available shortly after collection.

WorldView data allowed mapping of 13 different crevasse classes indicative of different types of complex deformation during the surge. Data is high-quality, but there is a long lag between collection and availability to science users (1-2 years).



RapidEye image of Negribreen Glacier, Svalbard from 23 July 2017. An enlargement of the ice stream appears on the right.

RapidEye derived surface roughness of Negribreen Glacier, Svalbard from 23 July 2017. Areas of increased surface roughness are indicative of crevassing during rapid acceleration of the glacier during surge in 2017 (maximal velocity 22m/day). This allows to monitor expansion of the surge in Negribreen.