

Initiation of a major calving event on Bowdoin Glacier captured by UAV photogrammetry

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In this study, we analyse the calving activity of Bowdoin Glacier, north-west Greenland, in 2015 by combining satellite images, UAV photogrammetry and ice flow modelling. During our 2015 summer field campaign on Bowdoin Glacier, using a long-range fixed-wing UAV (Unmanned Aerial Vehicle) we collected aerial images of the calving front before and after the initiation of a 1-km long fracture, which later induced a major calving event. Combining photogrammetrical techniques to infer georeferenced orthoimages, and feature tracking techniques, we obtained a high-resolution surface velocity field, which indicates a strong discontinuity at the crack location, see Fig. 1. A detailed analysis of the displacement field and the strain rates allowed us to map accurately the opening crack. Modelling results (see Fig. 2) indicated that the crack was about half-thickness deep, filled with water up to sea level, and getting irreversibly deeper when it was captured by the UAV. Later on, the crack deepening caused stress concentration around the tip, lateral propagation, and final collapse about two weeks later. The crack initiated in a highly crevassed area which is likely caused by a local bump of the basal topography between the medial moraine and the left margin, see Fig. 1. The asymmetry of bed at the front explains the typical calving pattern observed in spring and summer 2015, while a symmetric bed would have made calving events less predictable. Importantly, our results also evidence a subglacial depression directly behind the current calving front of Bowdoin Glacier, so that a rapid unstable retreat of the front must be expected in the coming years if the glacier keeps thinning.

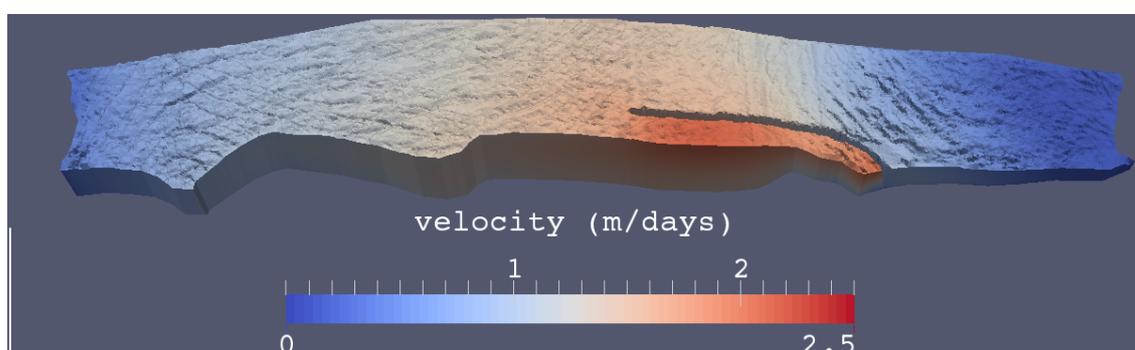


Figure 2: Velocity field modelled with ELMER/ICE.

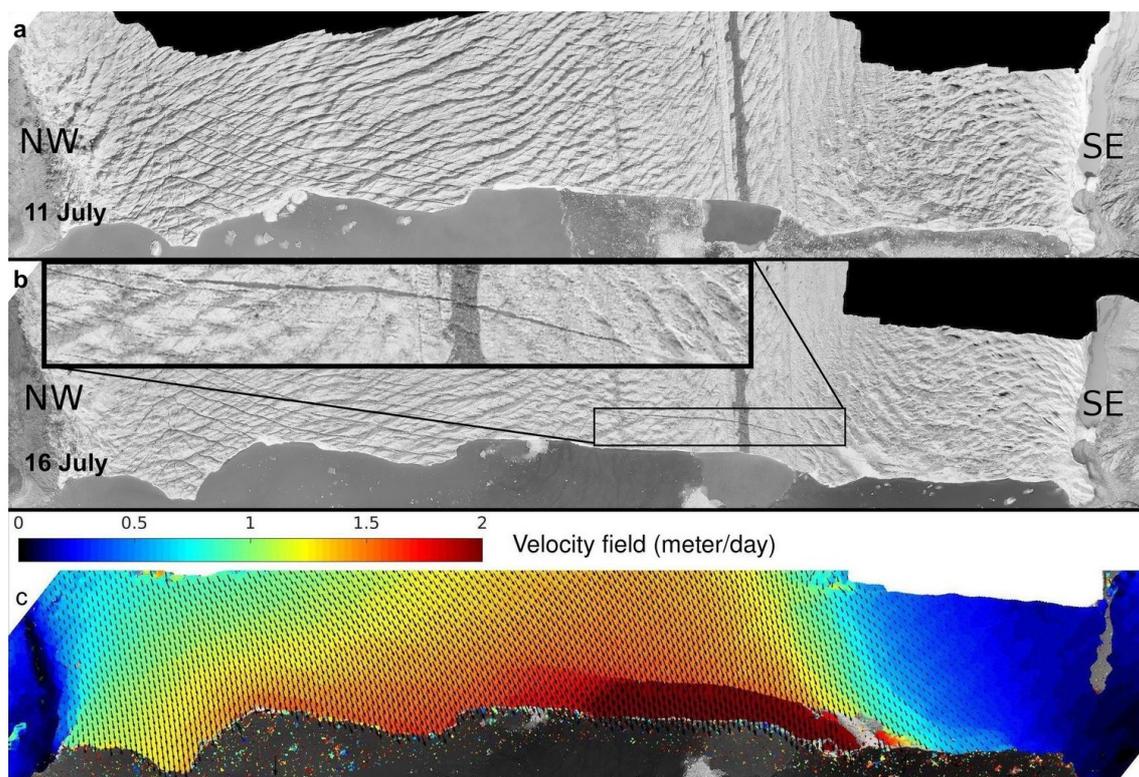


Figure 1. Calving front of Bowdoin Glacier: orthoimages obtained by UAV on the 11th (a) and the 16th (b) of July 2015, and resulting velocity field inferred by feature tracking (c), respectively. The discontinuity in the velocity field is due to the fracture, which appeared on the second orthoimage.

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