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Monitoring and modeling a recurrent major calving event at Bowdoin Glacier, Greenland

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Calving mechanisms are still poorly understood. The size and the frequency of calving events may vary by several orders of magnitude, making the development of an universal calving model challenging. At Bowdoin Glacier, Northwest Greenland, most of the yearly mass loss by calving is due to a few large events. Here, we analyse two major calving events in detail, which occurred nearly at the same location and followed a strikingly similar fracturing pattern. Our analysis relies on data obtained by interferometric radar and UAV photogrammetry during two summer fieldwork campaigns in July 2015 and July 2017. The crevasses likely deepened by hydro-fracturing, since a supraglacial river supplied them with water. Besides that, our high temporal and spatial resolution data reveals the influence of tides on the opening of the crack.
Here, we used the ice flow model Elmer/Ice to analyse the observations further. Modeling crevasse opening required the development of a dedicated remeshing routine for the crevasse. We use Elmer/Ice as a diagnostic, inverse model to identify key drivers of the crevasse opening and to determine possible combinations of water level inside the crevasse and crevasse depth that prevailed prior to the calving event. As a result, we find that the water level acts as a first-order control on crevasse opening rates. Finally, we apply the discrete element model HiDEM to study crevasse initiation and crevasse propagation with time and we test HiDEM's capability of reproducing the calving style observed at Bowdoin Glacier.