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3D Calving Modelling of Store Glacier and Rink Isbrae using Elmer/Ice and HiDEM

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Iceberg calving is a major mass loss component from both the Greenland and Antarctic Ice Sheets, but the complexity of calving processes and their links to climate mean that future sea level contributions from calving glaciers cannot currently be predicted with any certainty. Recognition of this uncertainty has led to a recent surge of observational and modelling studies, but so far a universal law for the prediction of calving rates remains elusive. Fundamentally, calving is a fracture process occurring across a range of spatial and temporal scales. This presents a major challenge for modelling calving: how can we represent discrete fracture events which lead to calving within the continuum modelling frameworks typically used for modelling ice dynamics?

We investigate this issue by comparing results from two very different calving models at two different glaciers. The models are 1) Elmer/Ice, a 3D finite element model equipped with a crevasse depth calving law, which has previously been used to successfully reproduce seasonal calving behaviour at a Greenland outlet glacier, and 2) HiDEM, a discrete element model which represents glacier termini as a matrix of connected particles, from which a range of observed calving behaviours emerge spontaneously. We use these models to simulate stress and fracture at the termini of Store and Rink Glaciers, two fast flowing outlet glaciers in the Uummannaq region of west Greenland. Comparing the results of the two models allows us to assess the performance of Elmer/Ice, and the choice of calving criterion, in predicting real world calving. Preliminary results suggest that rotational forces may be just as important, if not more so, than longitudinal extension in promoting fracture and calving.