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Simulating seasonal dynamics of Jakobshavn Isbrae through advancing the Elmer/Ice calving model

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Jakobshavn Isbrae, the largest outlet glacier in Greenland, accounts for over 20% of the mass loss from the Greenland Ice Sheet. The calving of such large, marine-terminating glaciers is an important yet largely unconstrained contributor to global sea level rise. Understanding the influence of changing environmental conditions on calving at influential glaciers is critical for projections of glacier retreat and sea level rise. This understanding remains poor, in part due to the inability of 3D calving models to robustly simulate calving dynamics and large-scale retreat at fast-flowing glaciers such as Jakobshavn Isbrae. It is important to overcome these modelling challenges, as modelling calving in 3D is necessary to understand the role of geometry and internal glacier dynamics on calving and identify the key environmental forcers at individual glaciers.

We present results from a new calving algorithm implemented in the 3D full-Stokes continuum model Elmer/Ice and applied at Jakobshavn Isbrae, West Greenland. Elmer/Ice fully resolves the glacier velocity and stress fields, whilst recent developments in the calving algorithm allow the modelled glacier to advance and retreat limitlessly along the fjord. A positional crevasse depth calving law is implemented within the calving algorithm, which we use to investigate the dominant processes behind large scale calving and retreat at Jakobshavn Isbrae. Furthermore, we investigate the robustness of the crevasse depth calving law to simulate terminus position. Preliminary results suggest the current incarnation of the crevasse depth law underestimates calving and the crevasse depth required to calve needs to be reduced to accurately simulate terminus change at Jakobshavn Isbrae. Additionally, the inclusion of an ice mélange backstress in winter simulations is key to seasonal terminus advance.