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A crevasse-depth calving law accounting for submarine melt undercutting

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The impact of submarine melting on calving is thought to be central in the response of marine-terminating glaciers to climate, yet we currently have no settled parameterisation that can represent this process in ice sheet models. The crevasse-depth calving law has been widely applied with arguable success, but in its present form accounts only for depth-mean stresses. As such, it does not account for the bending stresses induced by undercutting that may be key to the impact of submarine melting on calving.

Here, we combine elastic beam theory with linear elastic fracture mechanics to study the propagation of surface and basal crevasses near the front of tidewater glaciers in response to melt undercutting. We check our results against a numerical approach involving 2D elastic simulations and the displacement correlation method for estimating fracture depth. Our results suggest that bending stresses can play a significant role in modifying crevasse depth, with undercutting promoting the opening of surface crevasses and protruding 'ice feet' promoting the opening of basal crevasses. Lastly, we seek a revised crevasse-depth calving law that accounts for these effects.