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Calving dynamics and mélange buttressing conditions at the Thwaites Glacier calving face

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Thwaites Glacier, a large outlet glacier of the West Antarctic Ice Sheet, holds over a half meter of sea level rise equivalent. The large potential contribution to sea level is concerning given that the glacier may be vulnerable to self-sustaining processes of rapid retreat due to the retrograde bed slope that characterises much of the glacier's bed. Such a reverse-sloping bed exists behind the relatively high ridge on which the western calving front (WCF) of the Thwaites Glacier terminus currently rests. Our study focuses on the factors that control the calving dynamics of the WCF and the ability of mélange to influence these dynamics. Employing the 3D Helsinki Discrete Element Model (HiDEM), we find that calving at this location currently occurs as rifts form and widen due to longitudinal tensile stresses associated with ice flow across the grounding line. Calving is restricted in HiDEM simulations that include a constricted mélange field that is confined within the bounds of the model domain. A thicker, constricted mélange field fully suppresses calving. These simulations show the development of robust force chains that transmit resistive forces to the Thwaites WCF. In the future, the ability for mélange to influence the calving dynamics at the WCF will depend on the degree to which it is constrained in the wide Amundsen Sea Embayment, either through binding in land-fast sea ice or jamming behind large, grounded icebergs. As such, sea-ice conditions and iceberg characteristics will need to be considered along with the presence of mélange in investigations of the future retreat of the prominently recognised Thwaites Glacier.