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Three-dimensional modelling of calving processes on Johnsons Glacier, Livingston Island, Antarctica

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Iceberg calving is an important mass loss mechanism from ice shelves and tidewater glaciers for many mid- and high-latitude glaciers and ice caps, yet the process is not well represented in prognostic models of ice dynamics. Benn and others (2007) proposed a calving criterion appropriate for both grounded and floating glacier tongues or ice shelves. This criterion assumes that the calving is triggered by the downward propagation of transverse surface crevasses, near the calving front, as a result of the extensional stress regime. The crevasse depth is calculated following Nye (1957), assuming that the base of a field of closely spaced crevasses lies at a depth where the longitudinal tensile strain rate tending to open the crevasse equals the creep closure resulting from the ice overburden pressure. Crevasses partially or totally filled with water will penetrate deeper, because of the contribution of water pressure to the opening of the crevasse. This criterion is readily incorporated into glacier and ice sheet models, but has not been fully validated with observations. We apply a three-dimensional extension of Benn and others' (2007) criterion, incorporated into a full-Stokes model of glacier dynamics, to estimate the current position of the calving front of Johnsons Glacier, Antarctica. We develop four experiments: (i) an straightforward three-dimensional extension of Benn and other's (2007) model; (2) an improvement to the latter that computes the tensile deviatoric stress opening the crevasse using the full-stress solution; (iii) a further improvement based on finding the depth at which the model-computed tensile deviatoric stress, considered as a function of depth, equals the ice overburden closure pressure; (iv) an experiment that adds, to the above, the effect of a threshold strain rate required for crevasses initiation. We found that the improvements considered in experiments (ii) and (iii) were necessary to reproduce accurately the observed calving front. Our modelling results also suggest that Johnsons Glacier has a polythermal structure, in contrast with the temperate structure suggested by earlier studies.

REFERENCES:

Benn, D.I., R.J. Hulton and R.H. Mottram. 2007a. Calving laws, sliding laws and the stability of tidewater glaciers. Ann. Glaciol., 46, 126-130.

Nye, J.F. 1957. The distribution of stress and velocity in glaciers and ice-sheets. Proc. Roy. Soc., Ser. A, 239(1216), 113-133.