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A fracture mechanics model for the break-up of the Larsen Ice Shelf

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The recent retreat and collapse of the ice shelves on the Antarctic Peninsula has been associated with regional atmospheric warming, oceanic warming, increased summer melt and fracture processes. The major changes observed lately have been to the northern section of the Larsen Ice Shelf (Larsen A and B): Larsen A collapsed in early 1995 and the northern section of the Larsen B shelf collapsed in early 2002. In this paper we apply a fracture mechanics model to ice shelf flow models of the Larsen A and B ice shelves to predict the spatial distribution of surface crevassing. To do this we have used two flow models for the ice shelf, the first derived from satellite altimeter data of ice thickness (Doake et al., 1998) and the second from interferometric synthetic aperture radar (InSAR) data (Vieli et al., 2006). Strain rates derived from the model were then converted into principal stresses using Glen's generalized ice flow law. A fracture mechanics criterion (Rist et al., 1999, 2002) was then applied. The results reveal characteristic fracture patterns which we then compare to satellite observational studies that documented the break-up of the ice shelves. The fracture mechanics model predicts the spatial retreat of the ice shelf. Concentrations of fractures initiation points suggest the break-up was by propagation of edge cracks. These findings are discussed in relation to the stability of Larsen C.