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Environmental controls on micro fracture processes in shelf ice

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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 shelf flexure. Although the cause of collapse is a matter of active discussion, the process is that of fracture of a creep-brittle material, close to its melting point. The environmental controls on how fracturing initiates, at a micro-scale, strongly determine the macroscopic disintegration of ice shelves. In particular the shelf temperature profile controls the plasticity of the ice shelf; the densification of shelf ice due to melting and re-freezing affects the crack tip stress intensity; the accretion of marine ice at the bottom of the shelf imposes a thermal/mechanical discontinuity; saline environments control crack tip stress corrosion; cyclic loading promotes sub-critical crack propagation.
These strong environmental controls on shelf ice fracture means that assessing shelf stability is a non-deterministic problem. How these factors may be parameterized in ice shelf models, through the use of fracture mechanisms maps, is discussed. The findings are discussed in relation to the stability of Larsen C.