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Flow, fracture and modelled present stabilities of the Larsen C and northernmost Larsen D ice shelves

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We modelled the flow of the Larsen C and northernmost Larsen D ice shelves using an adapted continuum-mechanical model, and applied a fracture criterion to the simulated velocities to investigate its present-day stability. Constraints come from satellite data and geophysical measurements in the 2008-09 and 2009-2010 austral summer. We obtained excellent agreements between modelled and measured ice-flow velocities, and inferred and observed distributions of rifts and crevasses. Ice-shelf thickness was derived from BEDMAP and ICESat data and depth-density inferred from our seismic data. Notable exceptions occur in regions of modelled basal accretion down flow of promontories, thus placing the first quantitative constraints on their mechanical effects. Anomalously soft marine ice, advected into the ice shelf in flow-parallel bands, controls rates of rift propagation downstream.

Our model simulations confirm that the Larsen C ice shelf is stable in its current dynamic regime. Ice-mechanical heterogeneities in ice-stream suture zones, sustained by marine-ice production down flow of promontories, have significant stabilising effects on the ice shelf. Reduction in rates of marine-ice production could therefore lead to weakening of suture zones and possibly development of Larsen B-style dynamic conditions prior to its disintegration. First model studies with an extended continuum-mechanical flow model and fracture criterion allowing for ice-shelf mechanical heterogeneities show, that weakening of prominent marine ice-rich flow bands, inferred to be dominant in the north and south of Larsen C ice shelf would, promote Larsen B-style mechanical evolution. This emphasizes the importance of further research into the mechanics of suture zones and their dependency on marine ice provenance, together with thorough quantification of their modification of the ice-shelf stress regime and thus its stability.