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Fracture field for large-scale ice dynamics

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Recent observations and investigations emphasize the crucial role of ice shelf fracture mechanics in the discussion on the stability of the polar ice sheets and related uncertainties in the prediction of the rate of eustatic sea level rise. Most fracture growth criteria are based on the local stress or strain rate states. We account for fracture mechanics occurring in ice shelves and along its boundaries in the large-scale prognostic Potsdam Parallel Ice Sheet Model (PISM-PIK) by introducing a two-dimensional field variable. Fractures can be created and healed and existing fractures can be advected with the flow downstream. In addition to the localization of potential fracture zones also observed longitudinal surface structures can be easily explained. Crevasses and those band structures are observed to retroact the overall ice shelf dynamics. The memory of past deterioration links the dynamics at the front with those in the inner part of the ice shelf (even grounding line processes) in a more realistic way and gives rise to a fracture based calving parameterization at the ice shelf front.