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# The crucial influence of different material models on ice shelf calving

Julia Christmann (1), Ralf Müller (1), and Angelika Humbert (2)

(1) Institute of Applied Mechanics, University of Kaiserslautern, Germany, (2) Section of Glaciology, Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany

The aim of this study is to investigate the position and rate of small scale calving from Antarctic ice shelves. Thereby small scale calving happens on rather continuous timescales of several days to few years and contribute to the mass balance of an ice shelf. For a better understanding of the calving behavior, the stress and deformation states at the ice front are analyzed. The influence of geometry, material parameters and some model assumptions are discussed.

The ice shelf is modeled as a two, respectively three, dimensional body loaded by gravity and water pressure. There are two responses of ice to load: on long time scales ice reacts like a viscous fluid, and on short time scale like an elastic solid. Until now it is not obviously verified, if small scale calving is related to a purely elastic, a viscous or a visco-elastic material behavior. Therefore, the stresses and deformations due to these material models and their applicability on ice shelf calving are demonstrated. The maximum tensile stress respectively strain serve as a calving criterion, namely if one of these values exceed a critical bound at some point, a crack originates and the position of calving is determined.

The position of calving for a linear elastic material is unique, due to an instantaneous time-independent answer on the load situation. In this case, the determination of a calving rate is only possible, if a rate dependent geometry, loading or boundary conditions exist. Directly after a calving event the ice front is nearly vertical, however after a certain time interval the exposure, due to melting, waves and water flow, leads to time-dependent geometry variations whose influences on position and calving rate is indicated. Also the analysis of calving with a rate dependent material model leads to a calving rate, incorporating the position of maximum stress, detachment time and flow velocity of the ice shelf. The comparison of these results are established and the advantages and disadvantages are demonstrated. All models indicate, that the thickness at the front as well as the ice and salt water densities are the most critical parameters for the calving position.