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Fracture Mechanical Analysis and Finite Element Simulations of different Crack Scenarios in Ice Shelves

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Ice shelves are important elements of the climate system and sensitive to climate changes. The Wilkins Ice Shelf is located along the Antarctic Peninsula, a region, which experienced about 2.5K warming in the past 50 years, which is much higher than the global atmospheric warming. The Wilkins Ice Shelf has recently experienced major break-up events and lost since 1990 about 34% of its size.
Ice is a complex material which, depending on the context, can be seen as a viscous fluid as well as an elastic solid. A fracture event usually occurs on a rather short time scale, thus the elastic response is important and linear fracture mechanics can be used. The investigation of the stress intensity factor as a measure of the crack tip loading is based on a 2-dimensional analysis of a single crack with a mode-I type load and additional body loads. The investigation is performed using configurational forces within the process of the finite element software COMSOL. A depth dependent density and temperature profile is considered. The relevant parameters are obtained from literature, remote sensing data analysis and modeling of the ice dynamics. The applicability of different boundary conditions is discussed and the results are compared to semianalytical methods as presented in Rist, [1], Weertman, [2] and Van der Ween, [3]. The influence of water pressure on the crack faces in top and bottom crevasses is evaluated. This sets the basis for further studies on the impact of freezing water in crevasses.

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