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A higher-order thermo-mechanical ice-flow model applied to grounding-line simulations

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Despite recent advances in the understanding of polar ice sheets, their current mass balance is still not known. The mass balance of ice-sheet/ice-shelf systems is controlled by the dynamics of a small number of key components, namely the grounding line zones, outlet glaciers and ice streams. The major obstacle for mass budget studies is the lack of sufficient in-situ measurements of e. g. the three-dimensional velocity distribution. Numerical models represent powerful tools for cryospheric studies, because analytical solutions for the ice-flow in such studies are only feasible for special geometries and/or by applying significant physical simplifications. In order to derive realistic model simulations, it is decisive to include all relevant physical processes for ice-sheet flow, ice-shelf flow and grounding line migrations as well as for the thermo-mechanical coupling between ice-sheet and ice-shelf. Only a few numerical models exist that deal with the explicit treatment of ice flow across the grounding line. Therefore, model inter-comparisons represent important tools for assessing the plausibility of the results.

Here we present a three-dimensional, numerical, higher-order, ice-flow model to solve the relevant equations with the method of finite differences on a regular, time-independent grid. Results of commonly used geometrically simplified grounding line models are presented. We also demonstrate the importance of the numerical ice-sheet/ice-shelf coupling method through comparisons with our former flow-model, which is based on Blatter's shooting algorithm and coupled to an ice-shelf model.