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The zero-ice ice-flow problem

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When modelling ice flow, one often encounters the situation where melt is applied over ice-free areas. For example, determining the terminus position of a glacier involves finding the locations where applied surface melt and ice flow produces areas of zero ice thickness. How to best deal numerically this situation without producing negative ice thickness is an open and unsolved problem. One approach is to impose positive ice-thickness constraints and reformulating the problem as a constrained optimisation problem using the active-set method. This approach is, for example, used in the ice flow model *Úa*. I'll provide an overview over the approach used in the model and explain some difficulties, and how these have been addressed, associated with the use of higher order elements where the sign of the Lagrange multipliers can not be used to identify the active set.