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Stable and unstable eqiulibria in marine ice sheet flow: the role of ice shelves

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Marine ice sheets are thin-film flows that behave diffusively where the flow is in contact with solid ground, and hyperbolically (as a viscous thread or membrane) where the ice is afloat. These regions couple across a boundary layer that determines the rate of flow out of the grounded part of the ice sheet into the floating ice shelf, as described in Schoof (2007 & in press). In one spatial dimension, the floating shelf is a passive component of the marine ice sheet, and the evolution of the grounded portion of the ice sheet can be decoupled from that of the shelf. The evolution of the grounded sheet is then described by a slightly generalized Stefan problem, the free boundary being the sheet-shelf boundary or *grounding line*.

Equilibria can then be identified readily for the grounded sheet, and their stability can be understood in simple terms as an integrated mass conservation problem. Here we explore what happens in two spatial dimensions, when the floating shelf is confined to an embayment: the sides of the embayment then feauture in the force balance of the shelf and can reduce stresses at the sheet/shelf boundary. We explore a slightly simplified model for the flow of the shelf and its coupling with the grounded portion of the ice sheet. Depending on shelf geometry and the rate at which icebergs calve from the end of the shelf, many more stable equilibria can be generated by having a confined ice shelf attached to a marine ice sheet.

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