Geophysical Research Abstracts
Vol. 19, EGU2017-15789, 2017
EGU General Assembly 2017

Grounding line dynamics in the presence of lateral shear stress

Dan Goldberg (1) and Christian Schoof (2)

(1) School of GeoSciences, University of Edinburgh, Edinburgh, United Kingdom, (2) Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, Canada

The junction between grounded ice sheet and floating ice shelf – the grounding line – represents a problem on multiple scales. The fine details of the flow regime transition – from one dominated by vertical shearing on the grounded side to one dominated by longitudinal stretching on the floating side – determine the volumetric flux across the grounding line, and therefore the extent of a marine ice sheet, leading in some cases to a marine ice sheet instability (Weertman, 1974). The theory of Schoof (2007) quantifies this relationship and gives an approximate solution to the hydrostatic marine ice sheet equations within this transition zone. The assumption is made, however, that flow is entirely radial, and that horizontal shear stress (i.e. lateral drag) and transverse velocity can be ignored. Such an assumption may not hold, for instance, along the margins of an ice-flanked ice shelf, or along the boundary of an ice rise. Here we consider the problem of a one-dimensional marine ice sheet with fast sliding as in Schoof (2007), but with horizontal shear stress acting along the grounding line. For small to moderate shear stress, we derive semi-analytic expressions for the induced transverse velocity and horizontal shear stress within the grounding zone. We find that, though shear decays inland of the grounding line over a very short distance relative to the "longitudinal" boundary layer, its effect is to soften the ice through shear-thinning rheology, causing the grounding line flux to increase in proportion to the square of the shear. The results are validated through numerical modelling of a marine ice sheet on a downsloping bed. Although the effect of shear stress on grounding line position is minor in such a setup, the results have implications for the stability of ice rises, and furthermore yields an improved boundary condition for models of ice shelf flow.

Schoof C, 2007. Marine ice-sheet dynamics. Part 1. The case of rapid sliding. J of Fluid Mech, 573, pp 27-55.

Weertman J, 1974. Stability of the junction of an ice sheet and an ice shelf. J of Glaciology, 13(67), pp 3-11.