Calculating the Floating Fraction of Basal Ice Along Byrd Glacier, Antarctica, Using the Force Balance and the Mass Balance Connected by the Flow and Sliding Laws of Ice

Eunice Smith and Kevin Jones

Elizabeth City State University
Elizabeth City, North Carolina

A geometrical force balance that links floating fraction phi of basal ice to basal and side shear and to longitudinal tension and compression along an ice stream was combined with the mass balance along the ice stream using the flow law of ice and a sliding law of ice that incorporates the floating fraction of basal ice. This establishes the dependence of floating fraction phi on all the major stresses in an ice stream, the mass balance, the flow law, and the sliding law. The result is a second-order model that calculates how phi changes with the change of ice thickness upslope from the grounding line of an ice shelf supplied by the ice stream, and improves the first-order calculation of phi based on the force balance alone. The model is applied to a radio-echo flightline up Byrd Glacier, Antarctica, from the Ross Ice Shelf to converging flow in the East Antarctic Ice Sheet. The separate contributions of basal shear, side shear, and longitudinal tension/compression to floating fraction phi are presented along the flightline to show how these stresses change as flow changes from converging sheet flow to linear stream flow, to diverging shelf flow.