Freezing near the margins of an inactive ice stream

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We consider how the margins of an inactive ice stream, defined as the transition from a frozen bed to a bed containing liquid water, migrate over time. The presence of liquid water in the unfrozen bed area keeps the temperature there at the pressure melting point, and hence above the temperature at the same depth elsewhere in the ice sheet. This elevated temperature leads to high temperature gradients and hence freezing rates near the tips of the unfrozen bed area, which act as 'cooling fins' in the sense of heat conduction theory. Here we consider a mathematical model for the retreat of the tips, or end-points, of this unfrozen bed patch due to these high heat fluxes. We find that the retreat can be modelled using an integral equation, and present analytical solutions for the rate of retreat.