# How ice shelf morphology controls the longitudinal distribution of basal melting

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Satellite observations indicate that basal melting rates are spatially variable and strongly enhanced near grounding lines (e.g. Joughin and Padman 2003; Rignot and Steffen 2008). Ice-ocean modeling studies retain this pattern even with highly idealized topography and forcing (Holland, Jenkins et al. 2008), suggesting that large-scale ice shelf morphology may underlie longitudinal gradients in melting rate. Simulations performed using 3-D ocean models (Little et al. FRISP 2008) indicate that steep slopes drive entrainment of heat into the oceanic mixed layer, and that heat advected from these regions is a non-negligible component of the mixed layer heat budget. Here, a 1-D analytical model is used to explore how these factors influence the distribution of melting. When values for (highly uncertain) entrainment and boundary layer heat transfer velocities are specified, the simple model compares favorably with 3-D numerical results along the longitudinal axis of the ice shelf. In both models, melting rates are driven by the product of thermal forcing and flow speed; high temperatures in steep regions increase the spatial correlation of these properties near the ice-ocean interface and shift melting towards the grounding line. An intensification of cavity-wide melting rates driven by steeper ice shelves (the "basal slope feedback") suggests an instability in the coupled ice-ocean system, however, ice dynamics may mute this effect (e.g. Walker and Holland 2007).

Simple ice shelf-ocean models allow ice sheet responses to be explored at a high spatial resolution for a large parameter space. Adding a morphology-dependent distribution of basal melting will likely improve their ability to assess the basal slope feedback and the more general role of basal melting in ice shelf stability.

References

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