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Modelling subglacial drainage and its role in ice-ocean interaction

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Melting at the ice-ocean interface, both beneath ice shelves and at near-vertical tidewater margins, is strongly influenced by discharge of meltwater from beneath the grounded ice. The fresh water source can help to initiate a buoyant plume that rises up the ice face, entraining heat from the ocean to melt the ice. When the subglacial discharge is spatially and temporally variable, it can cause spatial and temporal variations in the melting rate, which in turn may influence ocean circulation in the cavity and ice flow within the shelf. Recent observations of channelized ice shelf bases may have their origin in variable subglacial discharge from beneath the grounded ice.

In this work, we use physically-based models of the subglacial drainage system to examine the likely mode of melt water delivery across the grounding line. We find that if subglacial channels (Rothlisberger channels) exist they can be expected to 'trumpet' out as the ocean is approached, due to a lack of confining stress to counteract wall melting. This causes a reduction in horizontal momentum in the water and can lead to pronounced localized melting around channel termini. This may lead to increased propensity for calving at such locations.

We also examine the effect of subglacial discharge variations on the evolution of a downstream floating ice shelf. We find that lateral variations in the flow across the grounding line can result in variations in plume-driven melting which evolve to create basal channels in the shelf aligned with the flow. The preferred spacing of the channels is controlled by a balance between buoyancy-driven acceleration and turbulent mixing in the ocean layer.