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Ocean processes near ice-shelf grounding lines

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Glaciological processes near grounding lines may influence the dynamics of inland ice, so it is important to understand the oceanic forcing of ice shelves in this region. The ocean beneath ice shelves is usually stratified by the release of fresh meltwater into the saline fluid. However, as the cavity shallows towards the grounding line, the effects of tidal mixing become proportionately more important until a 'tidal front' forms, beyond which the water properties are completely vertically homogenised.

The size of this well-mixed zone is important to several questions because the mixed ocean behaves in a different manner to the stratified region offshore. The ice-shelf melt rate is proportional to the product of ocean temperature and flow speed (turbulence). In a stratified ocean, meltwater release accelerates buoyant ocean flow, so ocean warming increases both temperature and turbulence and the product is an above-linear increase in the melt rate. In well-mixed regions tides control the ocean flow, so warming will lead to only a linear increase in the melt rate.

In this study a simple model is used to examine the size, properties, and sensitivities of the tidally-mixed zone near ice-shelf grounding lines. The model suggests that most mixed zones are small, implying that stratified-ocean models are generally valid and ice-shelf basal melting responds nonlinearly to ocean warming. The model elucidates the pattern of melting near grounding lines, illustrates the birthplace of Ice Shelf Water plumes, and confirms that melting in the small mixed zone increases linearly in response to ocean warming.