The effects of ocean turbulence and double-diffusive layering on the melting of ice shelves

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The melting of Antarctic ice shelves is likely to be enhanced by turbulence in the ocean boundary layer, which acts to mix warmer and saltier water towards the ice base. Here, we consider the case of a vertical ice face melting into the stratified ocean using high-resolution phase-change numerical simulations. The simulations are first validated against a series of classic laboratory experiments that were conducted at room temperature[1]. Once validated, we move to lower temperatures that are more representative of the geophysical ocean system.

The ocean dynamics show a complicated interplay between a turbulent buoyant meltwater plume and double-diffusive layers (Figure 1). The meltwater plume shows a clear laminar-to-turbulent transition as it rises through the domain, with a change in the melt rate of the ice associated with this transition. The double-diffusive layers appear adjacent to both the laminar and turbulent plume regions of the ice face, but are larger in the turbulent region. The double-diffusive layering height in the turbulent region matches reasonably well with the scaling prediction from the past study[1]. The application of these results to the real ocean system is also discussed, with implications for ice shelf melt rates.

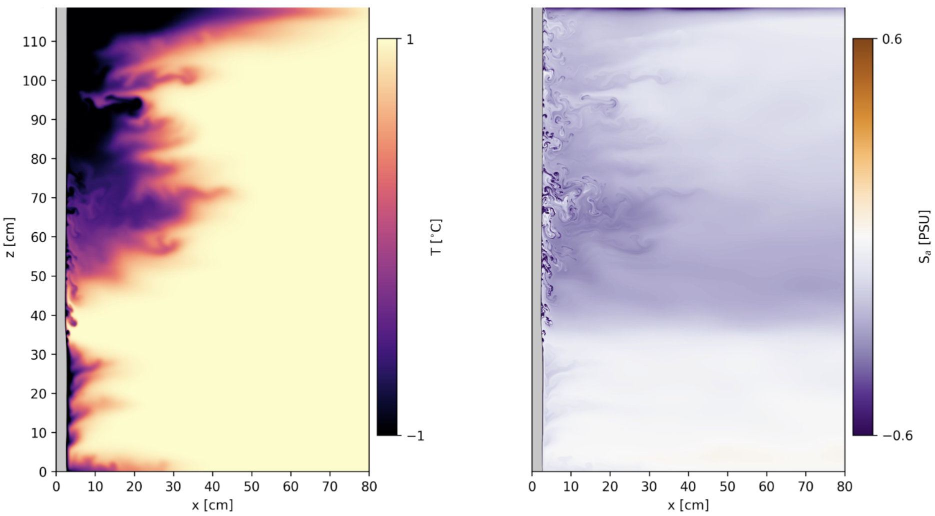

Figure 1: Snapshot of (a) temperature and (b) salinity anomaly from a linear stratification. The meltwater plume and double-diffusive layers near the ice face (grey region) are shown.

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[1]Huppert and Turner, *J. Fluid Mech.* **106**, 299 (1981).