Melting Icebergs in a Two-Layer Stratified Shear Flow

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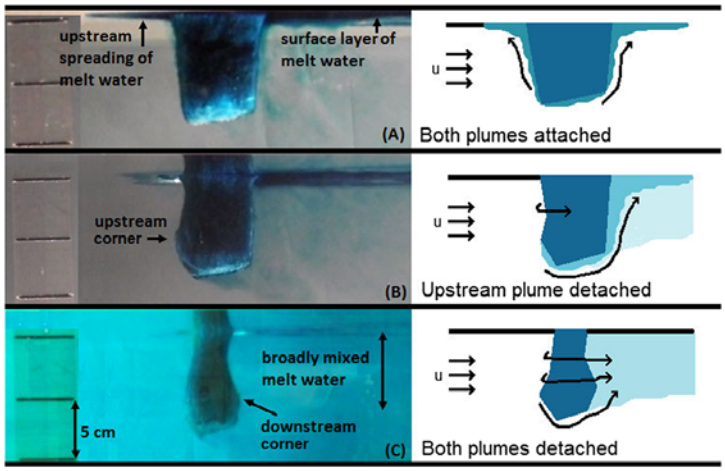
The calving of icebergs is responsible for approximately half of the ice loss from the Greenland and Antarctic ice shelves. Once icebergs have calved into the ocean, they are transported by ocean currents or atmospheric winds before melting into the ocean. How quickly and where they melt determines where the freshwater flux is released into the ocean, which in turn can affect the ocean stratification, sea ice formation and release of nutrients.



Currently, iceberg melt processes are poorly understood and modeled using crude parameterizations in numerical simulations (Bigg et al. 1997). Previous laboratory experiments conducted in the WHOI laboratory (FitzMaurice et al. 2017, 2018) have revealed the presence of two interesting and important regimes when an ice block melts into a two-layer sheared flow. When the flow past the ice is weak, fresh plumes of meltwater rise up the face of the ice until they spread at the surface (figure A). Here, the melt rate is influenced by the vertical plumes' velocity rather than the free stream current. However, once the flow velocity is sufficiently large the plumes are swept under and around the ice before reaching the surface (figure C). In this regime, the meltwater is spread over the entire water column before reaching the surface and the melt rate is strongly dependent on the ambient flow velocity.

This project will extend previous experiments to examine the influence of stratification on the melting of icebergs in a two-layer sheared flow. The previous experiments were conducted in a room temperature homogeneous salt fluid. These experiments will be conducted in a cold room and will determine how a two-layer stratification, mimicking that found in Greenland fjords, affects the melt rate and if similar regimes as in FitzMaurice et al. (2017, 2018) will occur.

Bigg, G. R., M. R. Wadley, D. P. Stevens and J. A. Johnson (1997), Modelling the dynamics and thermodynamics of icebergs, *Cold Reg. Sci. Technol.*, 26, 113-135.

FitzMaurice, A., Cenedese C. and Straneo F., 2018. A Laboratory Study of Iceberg Side Melting in Vertically Sheared Flows. *J. Phys. Oceanogr.*, 48, 1367–1373.

FitzMaurice A., C. Cenedese and F. Straneo (2017), Nonlinear response of iceberg side melting to ocean currents, *Geophys. Res. Lett.,* 44.