Chair: Physics of Fluids group

Understanding sheared convection at melting submarine glaciers

Description

Many environmental flows arise due to the heating of a vertical surface, such as the circulation in a room due to a wall heated by the sun. At marine-terminating glaciers, a similar convection flow occurs as the glacier melts, since the fresh meltwater is more buoyant than the adjacent salty ocean water. The fluxes of heat and salt through this convective, turbulent boundary layer control the melt rate of the ice, and so prediction of glacier evolution relies heavily on accurately modelling these fluxes [1].

Recent observational and experimental studies have highlighted shortcomings in existing parameterizations of ice melt at such glaciers [2]. One key finding from the observational study was the importance of a flow across the ice wall in addition to the vertical plume arising due to convection [3]. This project aims to precisely identify how a horizontal mean flow, driven by a mean pressure gradient, modifies the heat flux and the structure of the boundary layers in vertical convection.

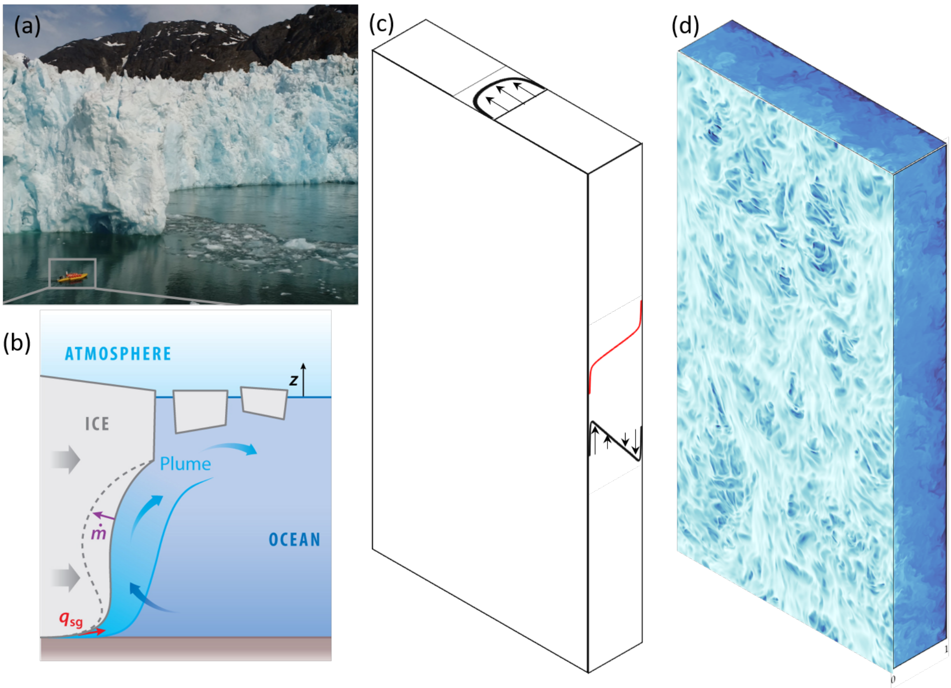

Figure 1: (a) LeConte glacier in Alaska, where elevated melt rates were recently observed by [3]; (b) a schematic of convection at the ice-ocean interface from [4]; (c) a simple schematic of the problem setup highlighting the mean flow of the system; (d) a temperature snapshot from a similar simulation *without* a mean horizontal flow.

Assignment

This project will involve using a state-of-the-art multiple-resolution code to perform numerical simulations of flow in a vertical channel, similar to the setup used by [5]. A mean horizontal flow will be imposed by a mean pressure gradient, and careful analysis of the simulation results will yield crucial information on how the heat flux through the domain depends on the Reynolds number and the Prandtl number.

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References

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