Mathematics Colloquium

How iceberg geometry affects melting: A multiphase fluids case study

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Friday, February 10, 2023
11:10 am – 12 p.m.
Building 38, Room 204

Abstract

Icebergs transport enormous amounts of fresh water as they melt, altering ocean circulation. We test existing melting parameterisations in a series of laboratory experiments. The parameterisations underestimate melting, and ignore the central importance of iceberg geometry. To understand how geometry affects melting, we turn to numerical simulation, and implement the phase field method in the Dedalus spectral code.The phase field method allows us to evolve the iceberg shape according to temperature and salt fluxes at the boundary. We also discuss how signed distance coordinates and asymptotic analysis can be used to improve the accuracy and efficiency of the phase field method. The simulations reproduce side-dependent melt rates and reveal that

1. at high speeds vortex generation generates localised melt rates up to double the average and
2. at low speeds double diffusive effects drive stronger convection and iceberg melting.

Time permitting, I may also discuss similar methods to simulate boat drag in dead water, and microscale polymer phase separation for cheap single-cell analysis.

About the speaker: Eric Hester received his Applied Mathematics PhD "Modelling Fluid-Solid Interactions" from the The University of Sydney in 2021 advised by Dr Geoffrey Vasil. His thesis improved volume penalty and phase-field methods for simulating moving, melting, and dissolving objects in fluid flows. He combined these methods with experiments to refine parameterisations of iceberg melting, and investigate how eddies influence boat drag in the dead water effect. He is currently a Hedrick Assistant Adjunct Professor in the Department of Mathematics at UCLA working with Prof Andrea Bertozzi and Prof Dino di Carlo, applying these tools to understand the multi-phase fluid dynamics of microparticle manufacture, as well as developing spectral accuracy fluid-solid interactions in the Dedalus computational framework.