How do ice cubes melt?

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Project description: Understanding oceanic fluid dynamics is crucially important to understand how momentum and energy gets distributed in the climate system. They are strongly constrained by the density contrasts between water masses, by the rotation of the Earth, and by the boundaries of the ocean. In the polar oceans, the melting/freezing seasonal cycle of sea ice is also very important in understanding what sets the vertical structure of the ocean, and vice-versa: the climatological environment determines how fast the ice will melt in the warmer months.

Loosely inspired by these questions, this project will investigate how ice melts in water that is under rotation or not, and that is salty or not. Preliminary investigations with ice cubes in tabletop experiments indicate that the motion of the ice and of the water surrounding it are radically different depending on these parameters, in ways that are quite counterintuitive.

You will examine the impact of rotation and salinity on ice melt using numerical simulations and tabletop experiments. You will examine how these factors impact ice melt rate, ice rotation, and meltwater dynamics. You will perform numerical simulations using the Python code "Dedalus" (https://dedalus-project.org) that you will run on parallel computers using a configuration we developed over the past few months. You will also have the option to develop a more robust lab setup using record players, food colouring, ice cubes, table salt, and DIYnamics materials (https://diynamics.github.io/index.html).

Requirements: We highly recommend that you have notions of vector calculus and partial differential equations, as well as some basic experience in programming. Knowledge about fluid dynamics and advanced notions of Python will be useful, but not expected prior to the start of the project.

Bibliography

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