Chair: Physics of Fluids group

How do fluid motions affect the melting dynamics of a drifting iceberg?

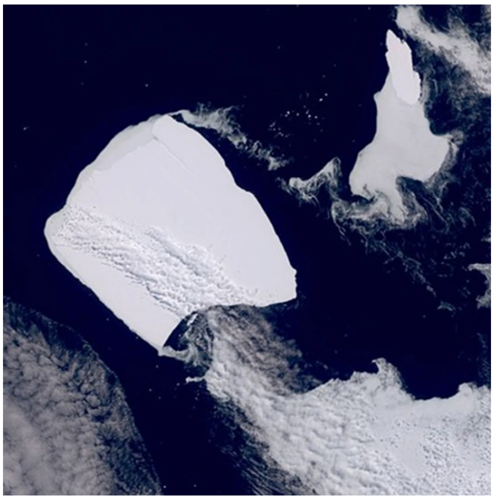
Description

The community working on climate predictions is faced with large uncertainties that notably originate from the difficulty to understand and model ice melting, since it controls the input of fresh and cold water into ocean currents, with long-lasting consequences [1].

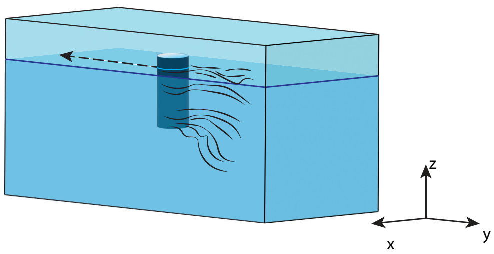
Modelling the melting of an iceberg is particularly challenging as it depends on its size, its specific geometry, the ambient temperature and salinity of the ocean, how fast it drifts in the ocean water, etc. This experimental project focuses on this last element: How does the motion of an iceberg influence its melting?

This aspect of the melting dynamics is extremely rich. A steady iceberg quickly shields itself with its cold fresh meltwater, therefore reducing its melt rate; on its opposite, a moving iceberg sees a continuous inflow of new hot salty sea water. The faster the iceberg drifts, the larger the discrepancy, but how much exactly? How does this motion sculpt the ice? How does it modify the motion of the meltwater rejected, and how much does the latter mix with the ambient? Another aspect of this challenge is that the motion of the iceberg can be self-induced: a recent study showed that dissolving candy can self-propel due to the specific dynamics of the residual liquid during dissolution [2].

Despite the existence of some work on ice melting in the presence of a flow [3], numerous fundamental questions have been left aside that must be answered to modify the present parameterizations of ice melting and therefore gain some predictive capacity even in the simplest configurations.



(a) Satellite image of a drifting iceberg.



(b) A (possible) lab-version of a drifting iceberg.

Figure 1

Assignment

Figure 1b shows a possible implementation of the laboratory-version of a drifting iceberg: an ice cylinder is kept vertical and dragged along in a tank. The plumes of meltwater rejected during melting are depicted with dark curves. Changing the ambient conditions (velocity of the ice, ambient temperature and salinity, ice geometry, ice size. . .) would enable to understand the melting dynamics by analysing the couplings between convection around the ice, melting, and buoyancy forces in the plumes. The moving ice can be tracked with cameras, the fluid motions around the ice could be quantified through Particle Tracking Velocimetry (PTV), and salinity/temperature measurements could be performed with several sensors.

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References

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