# Shape effect of ice melting in flow

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Iceberg melting is a critical factor for climate change, and not only a consequence thereof[1]. The shape of an iceberg is an important but often neglected aspect of its melting process. In this study, we investigate how different iceberg shapes and ambient flow velocities ($Re$) affect melting by employing direct numerical simulations. As share, we choose an ellipsoidal shape, with the aspect ratio $\varepsilon$ as the control parameter. The numerical results show significant variation in melt rate between different aspect ratios. Without flow, the optimal (minimum melt rate for a fixed volume) shape is the circle (2D) or sphere (3D) because then the surface area is minimal. However, our DNS reveals that the optimal shape changes as the ambient flow velocity increases, see figure 1. We give a theoretical explanation for the optimal shape based on the competition between the surface area and the convective heat transfer. Further, we theoretically derive the dependence of the melt rate on the aspect ratio, finding good agreement with the results. Our findings give insight into the interplay between phase transitions and ambient flows, thus improving our understanding of the iceberg melting process.

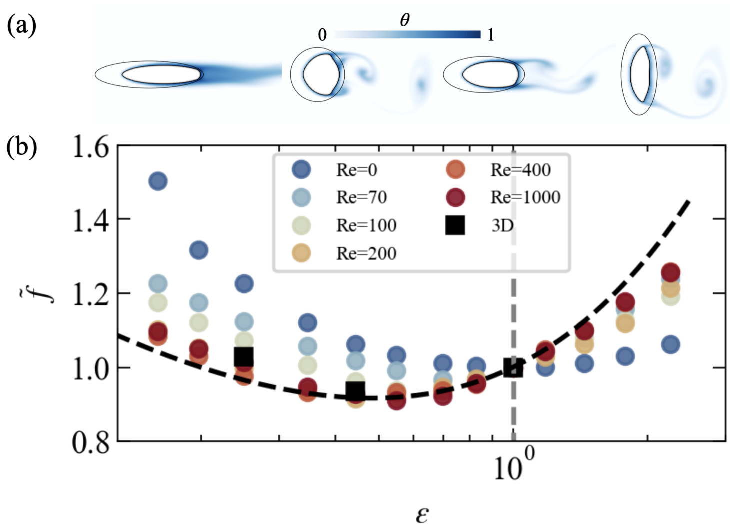


Figure 1: (a) Snapshots of the temperature ($\theta$) fields for different aspect ratios of ice melting in flow. From left to right: $\varepsilon = 0.25, 0.45, 1, 2.25$. The black contour line shows the initial shape. (b) The overall melt rate of ice as a function of $\varepsilon$ for different Reynolds numbers $Re$. The dashed line represents our theoretical prediction by assuming the boundary layer is laminar.

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[1]Cenedese and Fiamma. *Annu. Rev. Fluid Mech.* 55:377-402 (2023).