Melting of ice

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The quantitative understanding of glacial ice melting into the ocean is one of the most outstanding challenges in environmental fluid dynamics. The lack of understanding is on a fundamental level, due to the highly complex multi-scale, multi-physics nature of the problem. The process involves intricate multi-way coupling effects, including thermal convection, salinity, ocean current, and radiation, etc. As ice melts into the surrounding salty water, a decrease in local salt concentration leads to reduced water density, inducing upward buoyant forces and, consequently, upward flow. This flow dynamically interacts with the ice, resulting in a feedback loop of further melting (Stefan problem). Our investigation employs direct numerical simulations with the phase field method. To capture the intricacies of melting dynamics within turbulent flows, we implement a multiple-resolution strategy for salinity and phase field simulations [3]. The versatility of our method is demonstrated through successful applications to diverse melting scenarios, including the formation of melt ponds [2], melting in Rayleigh-Bénard convection [4], vertical convection with fresh water [1], and vertical convection with salty water [3]. In this presentation, we showcase results obtained across these various geometries. This work contributes to advancing our understanding of the complex dynamics involved in glacial ice melting within oceanic environments.

References

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