Melting of ice

Prof. Dr. Detlef Lohse,

Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen
und University of Twente

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. The versatility of our method is demonstrated through successful applications to diverse melting scenarios, including the formation of melt ponds, melting in Rayleigh-Bénard convection, vertical convection with fresh water, and vertical convection with salty water. 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.