Impact of externally-driven turbulence on ice melting in saltwater

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Résumé

Ice melting in ocean currents is a complex phenomenon that is currently poorly understood and crudely parameterized in climate models. When the base of ice shelves or icebergs melts in the ocean, a layer of fresh cold water emerges above the relatively warm and salty ambient, giving rise to thermal convection and double-diffusive convection processes. A key objective in polar oceanography is to understand the stability of the meltwater layer against natural double-diffusive convection and externally-driven turbulence due to, for instance, breaking internal waves or intense coherent vortices? To address the question of the meltwater layer stability, here we set up a laboratory experiment in a cold room with ice melting above saltwater with or without externally-driven turbulence. We perform simultaneously shadowgraphy to track the ice geometry, PIV to derive fluid velocities, and temperature and salt concentration measurements with a moving probe. For typical oceanic conditions, the layer of fresh cold water remains stable under the ice against natural convection, isolating the ice from the warmer deep salt water. Rayleigh-Bénard convection dominates below this protective layer and provides heat that is then transported diffusively. When external turbulence is added within the ambient (using a grid of pumps at the bottom of the tank), the meltwater layer becomes entrained within the salty ambient, shrinks, leading to a significant increase of the melt rate. Ultimately, we will show quantitatively how ambient turbulence combined with Rayleigh-Bénard convection influences ice melting.

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