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Laboratory experiments on Internal Solitary Waves in ice covered waters

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Oceanic internal waves (IWs) propagate along density interfaces and are ubiquitous in stratified water. Their properties are influenced strongly by the nature and form of the upper and lower bounding surfaces of the containing basin(s) in which they propagate. As the Arctic Ocean evolves to a seasonally more ice-free state, the IW field will be affected by the change. The relationship between IW dynamics and ice is important in understanding (i) the general circulation and thermodynamics in the Arctic Ocean and (ii) local mixing processes that supply heat and nutrients from depth into upper layers, especially the photic zone. This, in turn, has important ramifications for sea ice formation processes and the state of local and regional ecosystems. Despite this, the effect of diminishing sea ice cover on the IW field (and vice versa) is not well established. A better understanding of IW dynamics in the Arctic Ocean and, in particular, how the IW field is affected by changes in both ice cover and stratification, is central in understanding how the rapidly changing Arctic will adapt to climate change.

An experimental study of internal solitary waves (ISWs) propagating in a stably stratified two-layer fluid in which the upper boundary condition changes from open water to ice are studied for grease, level, and nilas ice. The experiments show that the internal wave-induced flow at the surface is capable of transporting sea-ice in the horizontal direction. In the level ice case, the transport speed of, relatively long ice floes, nondimensionalized by the wave speed is linearly dependent on the length of the ice floe nondimensionalized by the wave length. It will also be shown that bottom roughness associated with different ice types can cause varying degrees of vorticity and small-scale turbulence in the wave-induced boundary layer beneath the ice. Measures of turbulent kinetic energy dissipation under the ice are shown to be comparable to those at the wave density interface. Moreover, in cases where the ice floe protrudes into the pycnocline, interaction with the ice edge can cause the ISW to break or even be destroyed by the process. The results suggest that interaction between ISWs and sea ice may be an important mechanism for dissipation of ISW energy in the Arctic Ocean.

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