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Rapidly changing distribution of velocity and suspended materials under the drifting Arctic sea ice

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In two summer seasons of 2011 and 2014, the short-term (1-4 days) ice-camp study has been conducted on the drifting Arctic sea ice. In particular, in 2014, the international collaboration with the Marginal Ice Zone program (sponsored by Office of Naval Research) has been integrated. The mooring package comprises the acoustic Doppler velocity profiler, holographic imaging camera, and conductivity-temperature-depth profiler, which are used to understand the dynamic behavior of sea ice and spatial-temporal variation of mixing layer (ML) and suspended particulate matters under the sea ice.

Mooring data clearly shows the mixing and entrainment pattern in the upper ML in the marginal ice zone. When ice floes drift toward the pack ice, the upward entrainment from the seasonal pycnocline to sea ice-water boundary was induced by shear across ML and seasonal pycnocline. The entrainment speed was in the range of 0.25-2 m/hr, which matches well with thickening and thinning rate of ML during the near-inertial period ($\sim$12 hr). When ice floes drift toward the open ocean, the turbulent wakes at the advancing edge of ice were combined with the entrainment caused by near-inertial motion, which results in a complex mixing pattern of both upward and downward fluxes in the ML. Also, the acoustic backscatter observed by the acoustic Doppler current profiler and beam attenuation from transmissometer revealed the increased concentration of suspended particulate materials in the ML, which can be direct evidence visualizing the mixing pattern. Results suggest that the mixing and entrainment found in our study sustain particulate matters in suspension within the upper ML for a few months.