Quantification and characterization of turbulent mixing and heat budget within the surface mixed layer in the Pacific-side Arctic Ocean

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During RV *Mirai* Arctic cruise MR14-05, we carried out a fixed-point observation (FPO) for three weeks, from September 6 to 25, 2014, in the Northwind Abyssal Plain. In this study, turbulent mixing and heat budget in the surface mixed layer (SML) are argued in the Pacific-side Arctic Ocean. We collected a series of microstructure data set to calculate dissipation rates of turbulent kinetic energy (TKE) and thermal variance in the ship-based FPO program. Following FPO program, in summer, temporal change of SML was further explored by using “UpTempOs”, 60-m long drifting buoys with a thermistor chain. UpTempOs allow us to estimate the SML heat content, temporal and spatial changes in the SML depth.

During first week of FPO (6–8 September), high wind forcing, resulted from an atmospheric front passing over the station, deepened the SML. In the middle of September, surface winds were strong again because the station was located in the rim of the Beaufort High. For these gale wind periods, the wind events produced enhanced dissipation rates of turbulent kinetic energy in the order of magnitude of $\varepsilon = 10^{-6}$–10^{-4} W kg^{-1}. On thermal variance dissipation rate χ, it tends to be larger at the bottom edge of SML, corresponding to the greatest background temperature gradient, reaching the magnitude of $O(10^{-7})$ K^2 s^{-1}, resulting in vertical heat flux of $O(10)$ W m^{-2}.

According to the UpTempO observation, the turbulent ocean-to-ice heat flux was approximately 42 W m^{-2} in the marginal ice zone, whereas the diapycnal heat flux over the SML bottom was at maximum 1–2 W m^{-2}. Consequently, the ocean-ice heat transfer, rather than the diapycnal heat flux, is apparently dominant, and contributed more to melting of sea-ice floes in the early winter. This suggests that the horizontal heat advection near the water surface, originally emanating from the Chukchi Sea, could prevent ice growth in the neighboring marginal ice zone of the Canada Basin.

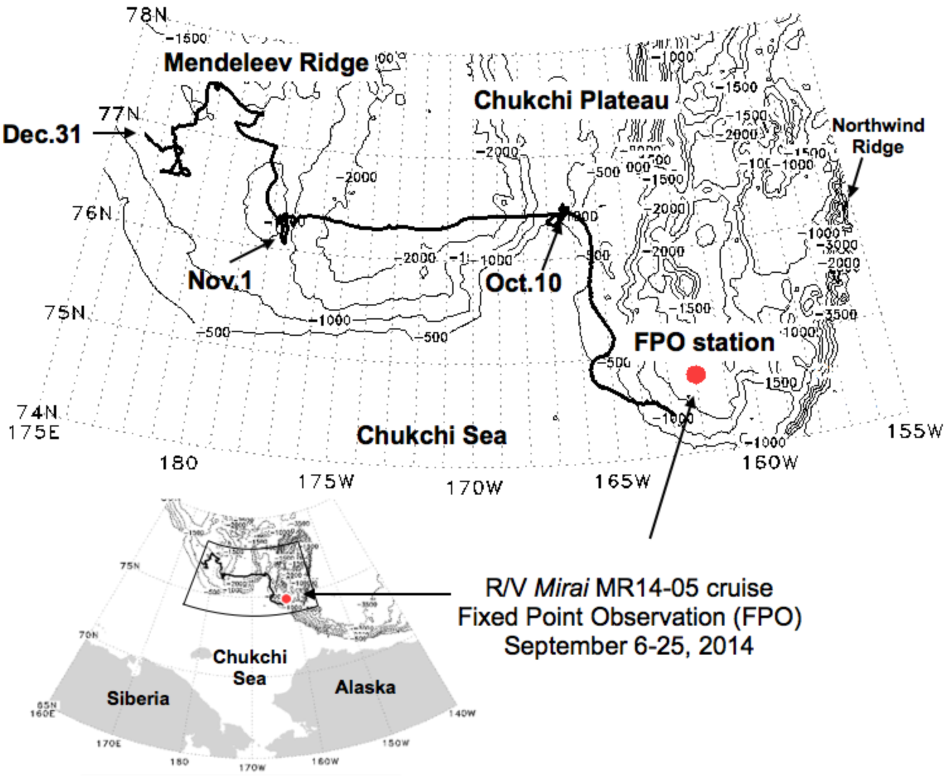

Figure 1: The study domain with bathymetric contours (contour interval is 500 meter) in Pasific-side Arctic Ocean. A dot represents the fixed-point observation (FPO) station that was conducted during the MR14-05 for the period of September 6–25, 2014. A thick line shows trajectory of the UpTempO buoy that was deployed on September 6 near the FPO station (70 km to the south).

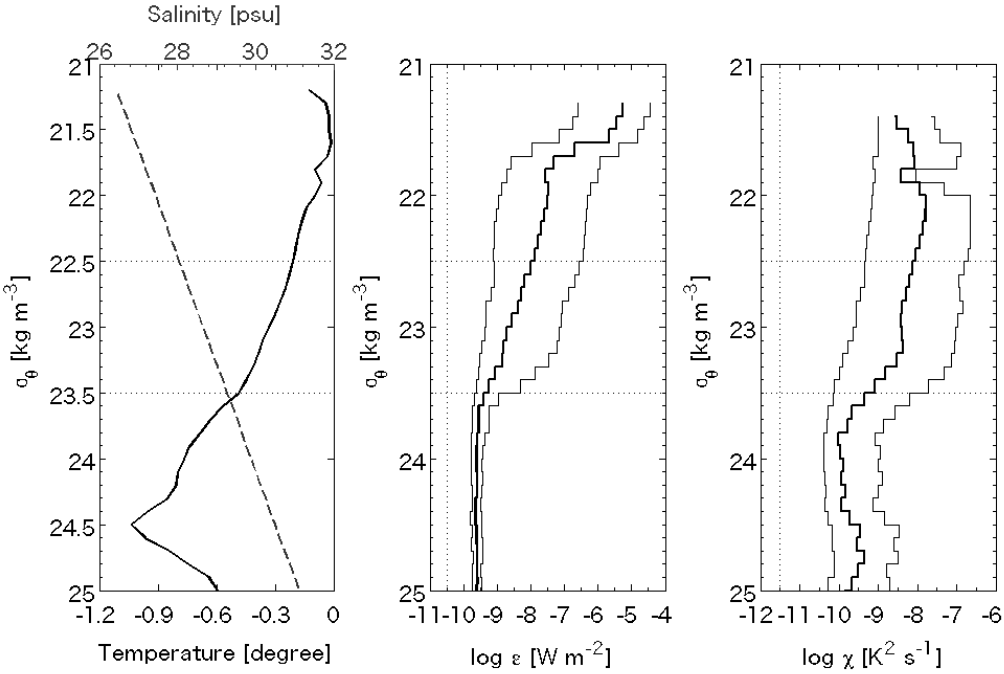

Figure 2: Vertical profiles of (left) temperature (solid) and salinity (dotted), (middle) $\log_{10}\varepsilon$, and (right) $\log_{10}\chi$. Note that all the profiles are averaged in the σ_θ coordinate. Envelopes in (middle) and (right) show the interquartile range of each quantity. Dotted horizontal lines of 22.5 and 23.5σ_θ mark approximate depths of SML bottom and vertical extetent of subsurface pycnocline.