Evolution of winter mixed layer in the Canada basin from 2015 to 2016

S. Kumakawa[1*], M. Yamamoto-Kawai[1]
[1]*Tokyo Univerxity of Marine Science and Technology*

Primary production in the Canada Basin is limited by nitrate. Only when winter mixing reaches nitracline, nitrate can be entrained into the surface layer. Therefore, the depth of the winter mixed layer and processes determing it are critical for primary productivity of the Canada Basin. Here we studied the evolution of winter mixed layer in the central Canada Basin using mooring observations. Temperature, salinity and pressure were measured by a profiler (from 45 m to 2000 m), and CTD sensors deployed at 36 and 38 m. We also collected water samples every 8 days (8 October 2015 to 7 October 2016) by a Remort Access Sampler (RAS, McLane) deployed at 38 m and analyzed samples for $\delta^{18}O$ ($H_2{}^{18}O/H_2{}^{16}O$).

On October 8 of 2015, when the observation began, mixed layer depth (MLD) was 29 m. On May 25 of 2016, MLD reached the maximum of 51 m. During this period, isopycnals below the mixed layer deepened by 10 m, suggesting the effect of Ekman pumping. Removing of this effect, winter MLD would be 41 m. Salinity of mixed layer increased from 26.1 of October 8 to 28.0 of May 25. As salinity determines density of polar waters, this salinity increment should be the reason of the mixed layer deepening from 29 to 41 m. The salt can be added to the mixed layer by brine rejection from growing sea ice as well by entrainment of higher salinity water at depth. We used two methods to calculate salinity increment by these two processes: from a relationship between salinity and $\delta^{18}O$, and from a 1-D mixing model based on salinity profile of October 8, 2015. The first method was applied only when RAS was in the mixed layer (from January 18 to May 25). The second method can be applied to the whole period, but ignores effects of advection. Both methods showed that salinity increment by brine was +1.1 and that by mixing was + 0.1 from January 18 to May 25. Based on the second method, salinity change by brine and mixing was +0.5 and 0.2, respectively, for the period between October 8 to January 18. Therefore, salinity increment by brine was estimated to be +1.6 from October 8 to May 25, accounted for ~84% of total salinity increment of +1.9.

On October 8, the depth of nitracline was ~61 m with salinity of 30.0. In order to reach this depth, salinity increment by brine needs to be +2.8 for 61 m of mixed layer. This requires 2.6 times of more salt than observed. As observed maximum sea ice draft at our observation station was ~2 m, 2.6 times more sea ice formation is not likely to occur. This suggests that winter mixing cannot bring nitrate to the surface layer to support primary production in the Canada Basin.