

Halocline Structures in the Subarctic North Pacific Detected by Argo Data

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The halocline is a region with a strong vertical salinity gradient, occurring between an overlying low-salinity layer and an underlying high-salinity layer. When the halocline has the dominant contribution to density stratification and thus creates a coinciding pycnocline, the vertical exchange of heat and substances such as nutrients is limited. In the subarctic North Pacific (SNP), a sharp halocline forms a pycnocline and dominates the vertical distribution of heat and biogeochemical parameters. This feature is thought to play an important role in air-sea interaction and biological production. However, the SNP halocline has been far less studied due to the limited availability of salinity data. Recent accumulation of Argo profiling float data has enabled expansive investigation of the halocline structure over the entire SNP. The spatial distribution and seasonality of the halocline in the SNP were investigated using Argo profiling float data. The permanent halocline (PH) showed zonal patterns in the spatial distribution of its depth and intensity. The PH tended to be shallow and strong in the eastern SNP but deep and weak in the west. Mean distributions of the PH depth and intensity corresponded to the winter mixed layer depth and sea surface salinity, respectively. In the Western Subarctic Gyre and Alaskan Gyre, where a relatively strong PH formed, PH intensity and depth showed clear seasonal variations, and deepening of the mixed layer compressed the underlying PH during the cooling period, resulting in intensification and development of the PH in late winter. In both regions, upwelling of high-salinity water also contributed to PH intensification. These results indicate the formation of PH through vertical winter mixing and upwelling. The summer seasonal halocline (SH) showed distinct zonal differences in frequency and intensity, which were opposite to the PH distribution. While an SH formed in the western and central SNP, it was seldom present in the eastern area. This zonal contrast of SH corresponded to freshening of the mixed layer during the warming period, primarily reflecting surface freshwater flux.

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