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Reanalysis of the formation mechanism of the Cold Water Belt in the southern Okhotsk Sea using I-129 as chemical tracer

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The southern Okhotsk Sea is an excellent fishing ground, producing 352 kton year^{-1} of scallops, crabs, salmon, etc. Fed by the Soya Warm current (SWC, high salinity) and the East Sakhalin Current (ESC, cold and low salinity), surface water of the southern Okhotsk can be grouped into Coastal and Offshore areas.
The Cold Water Belt (CWB) is formed by the upwelling of cold subsurface seawater. Hence, the CWB exhibits high biological production (Mustapha and Saitoh, 2009). The formation mechanism of the CWB has been studied leaving 2 theories: 1. The upwelling due to resonance and 2. The elevation of thermocline through baroclinic-wave adjustment. However, both theories allocate the source of the CWB before and after Soya Strait (at the intermediate cold water, ICW), respectively. To elucidate the nutrients' cycle at the southern Okhotsk Sea, it is indispensable to clarify the formation mechanism of the CWB. Along a wide range of oceanographic parameters, ^{129}I extracted from seawater as AgI was measured using accelerator mass spectrometry at the University of Tsukuba.
Prior to this study we found that ^{129}I is carried southward by the ESC. Likewise, in the surface waters ^{129}I (Offshore > Coastal) anti-correlates with salinity. In this study, after an identification of the different water masses based on their physical properties, we found that 1. The highest ^{129}I/^{127}I ratio was observed at OSW's subsurface (1.33-1.53 x 10^{-10}), which is modified by Sea Ice melting. 2. Dense-SWC, as Japan Sea's winter-mixed water, has higher ^{129}I/^{127}I ratios than SWC, but lower than Okhotsk Sea surface water (offshore area). 3. It is likely that ICW does not have a high ^{129}I/^{127}I ratio. 4. The CWB had a low ^{129}I/^{127}I ratio (< 1.10 x 10^{-10}), even lower than ICW's.
From the difference in ^{129}I/^{127}I ratios of the endmembers, it is likely that the main water mass conforming the CWB would have origins at the of Japan Sea's subsurface waters. Therefore, the upwelling due to resonance would be the most suitable. Such mechanism has been previously theorized as follows: when a stratified barotropic flow passes through the shallow (50 m depth) Soya Strait, internal Kelvin waves cause a nonlinear resonance with the seafloor, provoking a large boundary surface displacement that causes the lower layer to rise (Mitsudera et al., 2011a) at the Cape Krillion (at the left respect to the passing flow), whereas the baroclinic adjustment generated after the strong upwelling causes a strong baroclinic jet in the surface layer along the SWC axis and a dome–like structure in the subsurface layer (Mitsudera et al., 2011b). To quantify the role of the bottom Ekman upwelling (the second mechanism), a mass balance among endmembers including ^{129}I/^{127}I ratios, TS, chlorophyll-*a* and macronutrients data will be presented at the conference.

Student Submission

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