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Recent deoxygenation in the Japan Sea Proper Water in the northeastern Japan Basin

The Japan Sea is a semi-closed deep sea located in the northwestern margin of the North Pacific. Its deep layers below about 300 m is filled with a quite homogeneous water called Japan Sea Proper Water (JSPW). Here, a gradual decrease of dissolved oxygen (O₂) and an increase of potential temperature (θ) have been observed by hydrographic measurements since 1950s. The O₂ decrease and the warming have been considered to be associated with the weakened cooling and ventilation in winter due to climate change in the northwestern region of the Japan Sea where the JSPW is formed. In this work, we investigated the temporal variability in the properties of the JSPW in the northeastern Japan Basin of the Japan Sea where the water depth exceeds 3500 m, using high-quality data of ship-based measurements being conducted each year since 2010 by the Japan Meteorological Agency. From the vertical profiles of θ and O₂ and their temporal variabilities, the JSPW is classified into three distinctive layers such as the Upper JSPW, the Deep Water and the Bottom Water. The largest O₂ decreases (11 to 18 mol/kg for 2010-2017) was observed in the Upper JSPW between 500 m and 1000 m where the vertical gradients of θ and O₂ are both much larger than in the Deep Water below. Consequently, an O₂ minimum layer emerged at around 1000 m in 2013 and is being developed to date. The decrease of O₂ in the Upper JSPW accompanied the increase of nitrate, thereby they are attributed to the increased remineralization in this water. The decrease of O₂ and warming (4 mol/kg and 0.01C, respectively, for the same period) were also observed on $\rho_{\sigma_t} = 27.349$ kg/m³ in the deeper Bottom Water below 2500 m where the water is vertically uniform. The results of this study are helpful in understanding the difference of circulation structure in the Japan Basin, the formation of JSPW, and mixing and biological process. Further examination is also necessary to reveal the variability and its mechanism of warming and deoxygenation in the JSPW by analysis of a comparable high-quality hydrographic observation data in the Japan Sea.

Position

Senior Scientist

Affiliation

Japan Meteorological Agency

Email Address

nakano_t@met.kishou.go.jp

Are you a SFB 754 / Future Ocean member?

No

Primary author(s) : Dr NAKANO, Toshiya (Japan Meteorological Agency); Dr SASANO, Daisuke (Japan Meteorological Agency); Mr KITAGAWA, Takahiro (Japan Meteorological Agency); Mr NAGAI, Naoki (Japan Meteorological Agency); Dr KITAMURA, Yoshiteru (Japan Meteorological Agency); Dr AOYAMA, Michio (Japan Agency)

for Marine-Earth Science and Technology/Institute of Environmental Radioactivity, Fukushima University); Dr
ISHII, Masao (Meteorological Research Institute)

Presenter(s) : Dr NAKANO, Toshiya (Japan Meteorological Agency)

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