

Recent remarkable decrease of dissolved oxygen of the Japan Sea Proper Water in the northeastern Japan Basin

*Toshiya Nakano^{1,2}, Hidekazu Tanaka¹, Takahiro Kitagawa¹, Naoki Nagai¹, Yoshiteru Kitamura¹

1. Japan Meteorological Agency, 2. Meteorological Research Institute

The Japan Sea is a marginal and semi-closed sea located on the western North Pacific. Below about 300m depth is occupied by a relatively uniform water mass, and Uda (1934) named this water mass as the "Japan Sea Proper Water (JSPW)". Hydrographic observations since 1950's have revealed gradual increase of potential temperature and decrease of dissolved oxygen (DO) (e.g. Gamo et al, 1986; Minami et al., 1999). The cause of this warming and deoxygenation is considered to be weakening of winter cooling associated with the climate change in the northwestern region of the Japan Sea where the JSPW is formed. In this study, we investigated the temporal change of the JSPW in the northeastern Japan Basin where the depth exceeds 3500m, using the high quality hydrographic data obtained during the period of 2010 to 2016. The vertical profile of potential temperature and DO averaged over the Basin consists of three water masses, i.e., the "Bottom Water" of JSPW below 2500m depth, the "Deep Water" of JSPW between 2500m and 1000m depth, and the "Upper JSPW" between 1000m depth up to the thermocline. The Bottom Water is mostly uniform in both potential temperature and DO, and warmed by about 0.1C and deoxygenated by about -3.7 $\mu\text{mol}/\text{kg}$ during the period. In the Deep Water, potential temperature gradually increases upwards, while DO reaches its minimum at around 2000m depth and turns to increase above it. In the Upper JSPW, both potential temperature and DO show much larger upward increase compared with in the Deep Water. It is noted that temporal decrease of DO in the Upper JSPW between 1000m and 500m depths is about 10-18 $\mu\text{mol}/\text{kg}$. This decreasing speed is larger than that in the upper part of the Deep Water. Consequently, another DO minimum layer became apparent since 2013 at about 1000m depth, the boundary between the Upper JSPW and the Deep Water. In contrast, the potential temperature in the Upper JSPW warmed by about 0.1C, which is the same as in the Deep and Bottom Waters. In the Yamato basin, warming and decrease in dissolved oxygen are progressing as well, but no remarkable DO minimum layer could be seen. Several mechanisms are plausible and will be discussed to account for the complicated including double minimum DO layers, such as 1) decrease in the oxygen saturation by warming SST, 2) decrease of the JSPW formation and weakening of deep convection, 3) change of the mixing rate with low DO and rich nutrients waters, and 4) increase in consumption of DO associated with biological activity.

Keywords: northeastern region of Japan Basin, Japan Sea Proper Water, decreasing of dissolved oxygen

