Long-term thermohaline variations in the North Pacific subtropical gyre observed by repeat hydrography along the 165°E meridian

*Yuma Kawakami[1,2], Yoshiteru Kitamura[1], Toshiya Nakano[1,2]

1. Japan Meteorological Agency, 2. Meteorological Research Institute

Recently, long-term thermohaline changes in the surface and subsurface of the world ocean, such as the global warming and the intensification of salinity contrast between basins or regions, are continuously reported. Since changes of temperature and salinity greatly influence not only the density-driven geostrophic ocean circulation but also the marine ecosystem, sea levels and climates, monitoring of the ocean variations and understandings of those mechanisms are important.

Numerous scientific knowledges about thermohaline variations in the subsurface and intermediate layers of the North Pacific subtropical gyre including significant freshening in the thermocline/halocline and fluctuation in a decadal timescale were given by previous researches. However, many of them described in the western part of the subtropical gyre, and studies in its central part have been more limited partially due to the lack of data even though large scale atmospheric forcing generates great long-term thermohaline variations in there. Since thermohaline anomalies in the central North Pacific are mostly transported to the west by the Rossby waves or subsurface water masses flowing along the anticyclonic geostrophic circulation, examinations in the central subtropical gyre may be helpful for better understandings of thermohaline variations in the whole North Pacific.

In this study, we analyzed the repeat hydrography along the 165°E meridian maintained by Japan Meteorological Agency since 1996 to examine long-term thermohaline variations in the North Pacific subtropical gyre. As a result, in the subsurface of the southern part of the subtropical gyre corresponding to North Pacific Tropical Water (NPTW) characterized as the salinity maximum, a significant incresing salinity trend was detected. In this region, potential temperature and salinity also performed an inter-annual variation. On the other hand, in the greater part of the main thermocline/halocline, a significant decreasing trend was observed. In addition, potential temperature and salinity clearly fluctuated in a decadal timescale.

Causes of these variations were further investigated. Then we confirmed that variations in the subsruface around NPTW were originated in the surface mixed layer in the western part of its formation region to the east of the 165°E meridian by temporal changes of freshwater flux and eddy diffusion, and anomalies were transported by the westward geostrophic flow, as demonstrated by previous studies. We also found that thermohaline anomalies in the intermediate layers around the main thermocline/halocline derived from variations of winter mixed layer properties in the central North Pacific. A long-term variation of mixed layer temperature caused by changes of winter atmospheric forcing induced meridional migrations of isopycnal outcrops and thermohaline anomalies on there. Such anomalies were widely distributed to the subtropical gyre by mode waters such as North Pacific Subtropical Mode Water (STMW) in a few years.

Keywords: Repeat hydrography, Long-term changes, Decadal variability

