Changes of Antarctic Bottom Water in the central region (near 115°E) of the Australia-Antarctic Basin

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Changes of Antarctic Bottom Water (AABW) in the central region (near 115°E) of the Australia-Antarctic Basin were examined mainly with historical hydrographic datasets and recent observations of reasearch vessels and deep floats. From climatological views, the depth of the upper boundary (γ^n = 28.30) of AABW at the "hypothetical" station of 60°S 115°E has deepened, i.e. AABW has decreased its thickness, since around 1970 by the rate of about 15 m yr^{-1} (Figure 1a). The dataset showed that the freshening of AABW began before 1960 in the region. The freshening was accelerated in time; the rate is evaluated at –0.36 ×10^{-3}, –0.52 ×10^{-3}, and –0.89 ×10^{-3} yr^{-1} for the period of 1965-2019, 1990-2019, and 2000-2019, respectively, at the isothermal surface of –0.25 °C (Figure 1b). These climatological features are fairly consistent with those that had been reported on the AABW changes in the other regions in the Australia-Antarctic Basin.

After around 2010, however, the changes in AABW seemed to have modulated from these climatological trends. The thickenss of AABW was kept at almost the same level until around 2015, and then it has decreased rapidly (by about 50-100 m yr^{-1}). The isothermal salinity decreased rapidly by more than –1.0 ×10^{-3} yr^{-1} for the period of 2010-2015, and then the freshening seemed to be halted.

The recent modulations of the AABW changes near 115°E are similar to the recent changes in AABW off the Adélie/George V Land coast (around 140°E) (Kobayashi, 2018) at many points (Table 1); AABW there reduced its salinity largely by 0.005 in the austal winter of 2011 and then showed no clear freshening trends. The thickness of AABW had decreased rapidly by about 50 m yr^{-1} since aroud 2011. They are also different at several points; the former modulations probebly began about 4 years later of the latter occureances, and and the former changes were more gradual than the latters. These feasures would suggest that the recent modulations of the AABW changes near 115°E were derived from the arrival of the modified AABW from the east and ultimately attributed to the collapse of Mertz Glacier Tongue in February 2010.

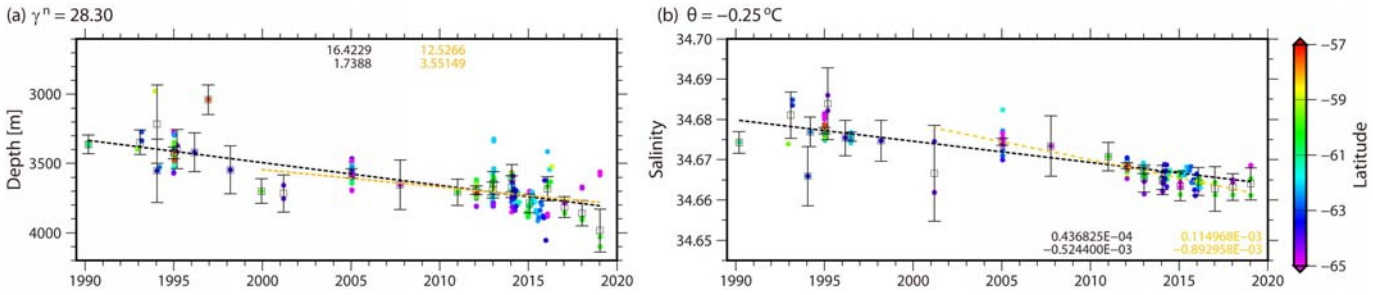

Figure 1. Change of (a) the depth of the upper boundary (γ^n = 28.30) and (b) the isothermal salinity (θ = –0.25 °C) of AABW at the "hypothetical" station of 60°S 115°E. The circles represent the observations and the colors denote their observed latitudes. The open squares with vertical bars represent the average and standard error for each survey. The dashed black and yellow lines represent the linear trends for 1990–2019 and 2000–2019, respectively.

Table 1. Comparisons of the recent modulations of AABW changes from the climatological trends between the regions near 115°E (this study) and off the Adélie/George V Land coast (from Kobayashi (2018) with an additial analysis).

Feature	This study (around 115°E)	Off the Adélie/George V Land coast (Kobayashi, 2018)
Rapid thinning	Began around 2015 (and it was confirmed to be continued until the summer of 2018/19). By about 50-100 m yr^{-1}.	Probably began in the austral winter of 2011 (and it was confirmed to be continued until the summer of 2014/15). By about 50 m yr^{-1} (and becoming slower gradually).
Large freshening	By the average rate of about –1.0 ×10^{-3} yr^{-1} (or more) for 2010-2015.	Salinity reduction of 0.005 during the austral winter of 2011.
Halt of freshening	Began around 2015 (and it was confirmed to be continued until the summer of 2018/19).	Began around the austral summer of 2011/12 (and it was confirmed to be continued until the summer of 2014/15).

References

Kobayashi, T., Rapid volume reduction in Antarctic Bottom Water off the Adélie/George V Land coast observed by deep floats, Deep-Sea Research Part-I, 140, 95-117, https://doi.org/10.1016/j.dsr.2018.07.014, 2018.