Argo格子データと粒子追跡法を用いた北太平洋回帰線水の潜り込み・移流過程の研究

Subduction and advection processes of the North Pacific Tropical Water investigated using the particle-tracking method applied to the Argo gridded data

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The North Pacific Tropical Water (NPTW), characterized by the highest salinity in the North Pacific subtropical pycnocline, is said to be subducted from the surface mixed layer in the central North Pacific along the Tropic of Cancer, where evaporation exceeds precipitation (Cannon 1966), and advected westward in the North Equatorial Current. At the 137˚E ,where repeat hydrographic surveys are conducted by the Japan Meteorological Agency, the NPTW is recognized as subsurface salinity maximum (Nakano et al. 2015). The NPTW is further advected to the western boundary region to feed high salinity to the Kuroshio source region south of Japan. A part of the NPTW is advected northward by the Kuroshio to the region where mode water formation (e.g., Oka 2009; Oka et al. 2011; Oka and Qiu 2012) occur actively. Variations in the subduction and advection of the NPTW may influence water properties (such as spiciness) in the region and hence the mode water formation. Thus, quantitative understanding of subduction and advection of the NPTW provides better understanding of variations in hydrography of the subtropical North Pacific.
The NPTW at 137˚E, defined as salinity larger than 34.9psu (Nakano et al. 2015), spreads from 10˚N to 23˚N (Suga et al. 2000) in the density range from 22 σ_θ to 25 σ_θ (Nakano et al. 2015). Suga et al. (2000) analyzed climatological distributions of outcrop position of 23-25 σ_θ isopycnal surfaces and the sea surface salinity (SSS) in winter, and found that the NPTW formation (subduction) region corresponds roughly to 20-30˚N, 140˚E-140˚W. The formation region was investigated in more detail by Katsura et al. (2013) who examined mixed layer salinity budget in the SSS maximum region and concluded that the formation region can be divided into two subregions (NW; 21-28˚N, 165˚E-172˚W and NE; 24-30˚N 165-140˚W). These previous studies implicitly or explicitly based on the assumption that the NPTW is subducted in the SSS maximum region. However, with depth-varying diffusivity in the pycnocline, the salinity maximum may not be conserved in a course of advection (Suga et al. 2000).
In this study, we investigate the subduction and advection processes of the NPTW at 137˚E using the backward particle-tracking method. Here, we assumed that particles were advected on isopycnal surfaces with isopycnal geostrophic velocity calculated from monthly gridded Argo-profiling float data, MOAA GPV (Hosoda et al. 2008). Temperature (T) and salinity (S) of the drifting particles were set to the MOAA GPV's T and S at the particle position. The NPTW in this study was defined as a water with S > 34.9psu and with σ_θ=22-25kg m^{-1} at 137˚E (Nakano et al. 2015). A total of 168584 particles were deployed along 137˚E section in each month between 2007 and 2016. The particles were tracked backward until January 2006 or until the particles were trapped into the mixed layer. In this study, the region where the particles were trapped in the surface mixed layer was regarded as the subduction region, and the number of the trapped particles was referred to as the subduction amount.

Results show that the area of positive subduction amount, i.e., subduction area, of the NPTW was distributed over larger region (10-30°N and 135°E-120°W, cf. Fig.) than considered in the previous studies. There were three peaks in the subduction amount, at (22°N, 139°E), (20°N, 175°E) and (125°W, 18°N). The NPTW particles around the first peak were subducted in March-April and passed the 137°E within a year after the subduction. The second peak roughly corresponds to the NW subregion of Katsura et al (2013). The particles in this region were subducted in March-April and arrived at the137°E within a couple of years. The third peak has not been reported so far. The NPTW particles in this region were subducted in May-June and arrived at 137°E in 4-5 years. Note that the area of the third peak did not correspond to the SSS maximum region. This means that salinity of the particles subducted in this region became higher in its westward advection. Interestingly, temporal variations in the NPTW temperature at 137°E were highly correlated (R=0.67) with the sea surface temperature (SST) variations at around the third peak with a lag of the advection time scale. Thus, SST in the eastern North Pacific seems connected to the western subsurface temperature, and hence might be linked to temperature in the Kuroshio region through the NPTW advection.

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