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Decadal change in bomb-produced radiocarbon in the Pacific Ocean revealed by WHP repeat hydrography

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Radiocarbon produced by nuclear weapon tests is one of ideal tracers for the air-sea gas exchange and ocean circulation. In the 2000s, radiocarbon in dissolved inorganic carbon was measured during revisit cruises along the WOCE (World Ocean Circulation Experiment) lines of P01 (47N approx., 2007), P03 (24N approx. 2005), P06 (32S approx., 2003), P10 (149E approx., 2005), P13N (165E approx., 2011), P14N/C (179E approx., 2007), P17N (135W approx., 2001), and P21 (17S approx., 2009) conducted in the 1990s in the Pacific Ocean. Comparison of radiocarbon data from the 1990s and 2000s revealed decadal changes of radiocarbon concentration in the thermocline, most of which were due to temporal changes in the bomb-produced radiocarbon. Vertical profiles and vertical-integrated inventories of the bomb radiocarbon in the subarctic and equatorial regions have not changed significantly. In the subtropical regions, radiocarbon decreased in upper thermocline from surface to about 500-m depth. In contrast, radiocarbon increased in lower thermocline from about 500-m to 1500-m depths. In the southern and northeastern subtropical regions, the two opposing directions in radiocarbon change resulted in small temporal changes of the total inventory of the bomb radiocarbon. On the other hand, the water column inventory significantly decreased in the northwestern subtropical region because the radiocarbon decrease in the upper thermocline was larger than the radiocarbon increase in the lower one. These decadal changes are primarily due to the meridional transport of the bomb radiocarbon from high latitude into temperate zone. The decrease in the vertical-integrated radiocarbon in the northwestern subtropical region implies that the turnover time of the thermocline circulation in the region is faster than those in the other subtropical regions in the Pacific Ocean. In addition the loss of the bomb-radiocarbon in the North Pacific Ocean could be explained by its transformation to the Indian Ocean via Indonesian Through Flow. This work was partially supported by Japan Society for the Promotion of Science (JSPS) KAKENHI Grant Number 18310017 and the Common-Use Facility Program of JAEA (2007A-F03, 2007B-F05, 2008A-F02, 2009A-F05, 2010A-F06, and 2011A-F04).

Keywords: bomb-produced radiocarbon, Pacific Ocean, ocean circulation