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Long range transport of radiocaesium derived from global fallout and the Fukushima accident in the ocean interior of the Pacific Ocean since 1960s through 2017

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The world's oceans act as a sink for artificial radionuclides as well as for other anthropogenic pollutants released into the environment. Owing to physical and biogeochemical processes in the ocean, artificial radionuclides in the ocean are redistributed from their initial entry points which depend on the various sources. Long range transport of radiocaesium in the ocean interior were investigated and presented. Radiocaesium were derived from global fallout which occurred mainly late 1950s and early 1960s and the Fukushima accident occurred in 2011. In the ocean interior, main factor is subduction of mode water formation from surface to two mode waters, STMW and CMW. Radiocaesium then stayed long in both STMW and CMW, but relatively first recirculation and southward movement were observed in STMW for decadal time scale.

We establish database for artificial Radionuclides in the marine environment as HAM global 2018, doi: 10.34355/CRiED.U.Tsukuba.00001, and we reconstruct 137Cs activity concentration sections for 1965-1968 and 1970-1973 to understand initial conditions of 137Cs activity concentration in ocean interior just after large atmospheric fallout in early 1960s and 5 years after injection. We also carried out observations at stations between 49 deg. N and 60 deg. S along 165 deg. E in 2002, 2012 and 2015. After that, we also observed vertical profiles in the western North Pacific Ocean.

Basic feature of radiocaesium distribution along 165 deg. E section in 1963-1965 was dome shape distribution of which deepest places were around 30-40 deg. N and of which maximum depth were around 600- 800 meter depths. The penetration of 137Cs is found less than 800 m depth, associated with the bowl shape of isopycnals in the midlatitude region. In general, the 137Cs activity concentrations in the subsurface and intermediate water of the mid latitude region of the

western North Pacific were higher than those in surface waters of the subtropical and equatorial Pacific. In 2002, we observed two 137Cs activity concentration maxima at 250 m and at 400 to 500 m depth at around 20 deg. N. The 137Cs activity concentration at the core at 400 to 500 m depth in 2002 was around 2 – 3 Bq m-3 and the start of moving in 1963-1965 was 16 Bq m-3 which indicates only one thirds of dilution occurred during about 40 years travel in the ocean interior as CMW. In 2012, we also observed two 134Cs activity concentration maxima at 150 m, 30 deg. N and at 300 m depth at 40N, while we observed a Fukushima derived at 300 m, 30 deg. N with southward movements. Basic feature of 137Cs distribution derived from atmospheric weapons test along 165 deg. E section in 2012 still keep dome shape distribution of which deepest places were around 30-35 deg. N and of which maximum depth were around 400 meters depths, while deepest places were around 20-30 deg. N in 2015. These findings strongly suggest that radiocaesium has been transporting in the ocean interior by subduction of mode waters from subarctic region to subtropical region and tropical region.