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Southward transport of radiocesium discharged directly from Fukushima Dai-ichi nuclear power plants across the Kuroshio Extension Current

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The massive Tohoku earthquake and consequent giant tsunami of March 11, 2011 resulted in global releases of radiocesium (Cs-134 and Cs-137) in the environment from the Fukushima Dai-ichi nuclear power plants (FNPPs). In the North Pacific Ocean, a large portion of Fukushima-derived radiocesium has been settled both through atmospheric deposition and direct discharge. Evaluation of Fukushima-derived cesium isotopes in the ocean is necessary to address risks to marine ecosystem and public health. Meanwhile the contaminants are potentially ideal tracers for material cycles and seawater circulation in the ocean. We present here Fukushima-derived radiocesium in seawaters at stations in the northwestern Pacific Ocean hundreds km away from FNPPs in February 2012. Surface and deeper samples (25–800 m) were collected into 20-L cubitainers using a bucket and a conductivity-temperature-depth rosette with water samplers, respectively. The sample were filtrated and acidified by nitric acid on board. Radiocesium in the seawater sample was concentrated onto ammonium molybdophosphate (AMP). The radiocesium in the AMP/Cs compound was measured using a gamma-spectrometry with well-type Ge detectors. Fukushima-derived radiocesium was found at all the stations from 20°N to 42°N about one year after the disaster. Concentration of radiocesium in the surface mixed layer (0 $\sim$ 150-m depth approximately) was highest in the transition area between the subarctic and subtropical regions ($\sim$ 20 Bq/m3) because of the direct discharge of radiocesium from FNPPs into the transition area. The surface concentrations in the subarctic and subtropical regions were less than 5 and 1 Bq/m3, respectively, most of which were probably derived from the atmospheric deposition of Fukushima-derived radiocesium. Below the surface mixed layer the Fukushima-derived radiocesium decreases sharply and was not detected below 400-m depth at stations in the subarctic region and transition area. However at stations just south of the Kuroshio Extension Current, which is boundary between the transition area and subtropical region, we found obvious maxima of radiocesium just below the mixing layer and deeper penetration depth of the Fukushima-derived radiocesium. Water density range of the subsurface and deeper layers in the subtropical stations where the Fukushima-derived radiocesium was observed agrees with those of the mixing layers in the transition area where the relative high concentration of Fukushima-derived radiocesium was measured. These results suggest that the radiocesium discharged directly into the transition area have been transported southwardly to the subtropical region across the Kuroshio Extension Current during the past one year.