Temporal change in Fukushima-derived radiocesium in the western subarctic region of the North Pacific Ocean

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The accident of Fukushima Dai-ichi Nuclear Power Plant occurred in March 2011 resulted in release of 20-40 PBq radiocesium into the environment. It is estimated that 70-80% of them deposited and discharged in the North Pacific Ocean and most of them are dissolved in seawater. Therefore, Fukushima-derived radiocesium has been spreading throughout the North Pacific along the surface water currents with dilution by seawater mixing. Previous studies revealed that radiocesium deposited and discharged in the coastal area of Japan was transported eastward along the surface current in the mid-latitude of the North Pacific Ocean and reached the west coast of the North American continent in 2015, about four years after the accident. We collected seawater samples during Japan Agency for Marine-Earth Science and Technology "Hakuho Maru" cruise conducted in the western subarctic region of the North Pacific in the summer of 2017 and measured activity concentrations of radiocesium in them. Because the activity concentration of Fukushima-derived ^{134}Cs has decreased to less than 1 Bq m^{-3} due to dilution and radioactive decay (its half-life is about 2 years), it is difficult to measure it unless it is concentrated. For the concentration, Cs resin (potassium nickel ferrocyanate on polyacrylnitrile, KNiFC-PAN) manufactured by Triskem was used. About 40 L of seawater sample was passed through 5 ml (about 1 g) of the Cs resin at a flow rate of 50 ml min^{-1} to concentrate the radiocesium in the resin. Stable cesium (^{133}Cs) chloride was added as a carrier to the seawater sample (concentration was about 100 ppb), and the recovery rate of radiocesium was estimated to be about 95% from a difference in ^{133}Cs concentration before and after the passing through the seawater sample. After washing the Cs resin in our laboratory on shore, activity concentrations of ^{134}Cs were measured using gamma ray spectrometers (Ge semiconductor detectors) in Kanazawa University. The decay-corrected activity concentration of the Fukushima-derived ^{134}Cs was 0.43-1.2 Bq m^{-3} in the surface mixed layer (above 200 m) of the western subarctic region in June 2017. Below that depth, the concentration was lower than the detection limit (about 0.4 Bq m^{-3}). The vertical water-column inventory of ^{134}Cs was estimated to be 186 ±46 Bq m^{-2} that was lower than that observed in the same region in July 2014 (283 ±45 Bq m^{-2}). In the western subarctic region, the ^{134}Cs inventory decreased exponentially between June 2011 and July 2014. The decreasing rate between July 2014 and Jun 2017 is smaller than that between June 2011 and July 2014, which implies a return of the Fukushima-derived ^{134}Cs to the coastal area of Japan along with the western subarctic gyre current.

Keywords: Fukushima Dai-ichi nuclear power plant accident,, Radiocesium, The western subarctic region of the North Pacific

