1–15 Prediction of the Dispersion of Radionuclides Released into the Ocean

— Dispersion Simulation of Radionuclides from Coastal Regions to the Open Sea —

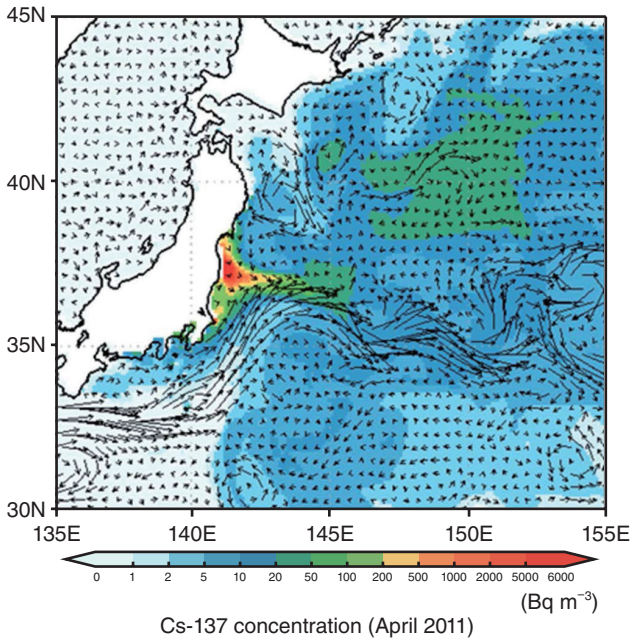

Fig.1-34 Averaged surface ^{137}Cs concentrations in April
Simulation results suggested that the ^{137}Cs concentrations in the coastal and offshore oceans were influenced by the Kuroshio Extension.

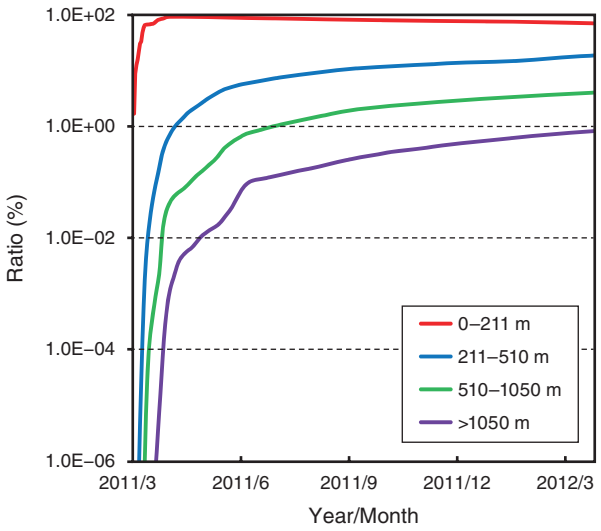

Fig.1-35 Time series of the ratios (%) of ^{137}Cs amounts in the surface, intermediate, deep, and bottom layers to the total release amount of ^{137}Cs
Simulation results suggested that one year after the 1F accident, the accident-derived ^{137}Cs was transported to layers below a depth of 200 m.

Cesium-137 (^{137}Cs) was released to the ocean by the accident at the TEPCO's Fukushima Daiichi NPS (1F). Many observational and simulation studies have been carried out to clarify the oceanic dispersion. Numerical simulation is a powerful methodology for understanding the spatiotemporal characteristics of oceanic dispersion of accident-derived radionuclides. Unfortunately, the quality of oceanic-dispersion simulations is degraded by uncertainties in the source term and simulated ocean currents. In this study, oceanic-dispersion simulations were carried out by an oceanic-dispersion model using output data from five oceanic general-circulation models. By comparing these simulation results, we objectively analyzed the effect of different oceanic data upon the ^{137}Cs-dispersion simulation. Then, we analyzed the ^{137}Cs dispersion from the coastal region of Fukushima to the North Pacific Ocean.

In this study, we applied the SEA-GEARN oceanic-dispersion model developed at JAEA. Input oceanic data were calculated by oceanic general-circulation models of the Japan Marine Science Foundation (JMSF), the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), the Meteorological Research Institute (MRI) of the Japan Meteorological Agency (JMA), and the National Oceanic and Atmospheric Administration (NOAA). The data-assimilation method was applied to these oceanic general-circulation models to assimilate observed data into numerical simulations. The direct-release rate of ^{137}Cs into the ocean was estimated by means of the observed sea surface ^{137}Cs concentrations near the northern and southern discharge channels of 1F. To provide the ^{137}Cs-deposition amounts at the sea surface, we conducted an atmospheric-dispersion simulation using the latest-estimated ^{137}Cs release rate into the atmosphere.

Compared to the simulation with a lower horizontal resolution, the higher-resolution simulation reproduced well the ^{137}Cs concentration observed in the coastline and offshore of Fukushima prefecture. The ^{137}Cs was suggested to have been spread along the coast in the north–south direction during the first few months after the 1F accident. The simulations for the western part of the North Pacific and the whole North Pacific reproduced the main ocean current favorably using the data-assimilation method, despite the relatively low resolution. This suggests that the Kuroshio Extension plays a large role in the transport process of ^{137}Cs from the coast to the outer ocean (Fig.1-34).

Analysis of the depth distribution of ^{137}Cs by the dispersion simulation showed that most of that transferred to the ocean by direct release or deposition from the atmosphere existed in the surface layer (0–211 m from the sea surface) shortly after the accident. However, as time passed, it was transported from the surface layer to deeper layers (Fig.1-35). The ^{137}Cs amounts in the surface, intermediate (211–510 m), deep (510–1050 m), and bottom layers (deeper than 1050 m) one year after the 1F accident were 71, 19, 4, and 0.8 % of the total release amount, respectively.

This study suggests that the accident-derived ^{137}Cs was dispersed widely into the North Pacific and gradually dispersed from the surface to the deeper layers by simulations, regardless of the different ocean-current data. A future task is to carry out oceanic-dispersion simulations over the whole North Pacific for several decades to quantify the time-series change of ^{137}Cs abundance.

Reference

Kawamura, H., Kobayashi, T. et al., Oceanic Dispersion of Fukushima-Derived Cs-137 Simulated by Multiple Oceanic General Circulation Models, Journal of Environmental Radioactivity, vol.180, 2017, p.36–58.