Detection of Fukushima-derived radionuclides in seawater, zooplankton, and small fish off Japan

Presenters
Jun Nishikawa (Department of Marine Ecosystem Dynamics, Atmosphere and Ocean Research Institute, University of Tokyo, Assistant Professor)
Hiroomi Miyamoto (Center for International Collaboration, Atmosphere and Ocean Research Institute, University of Tokyo, Research Fellow)

Outline

Assistant professor Jun Nishikawa and research fellow Hiroomi Miyamoto of the Atmosphere and Ocean Research Institute, University of Tokyo, were part of an international team of researchers investigating radionuclides in the Pacific Ocean 30-600 km offshore from the Fukushima Dai-ichi nuclear power plants (NPPs). In June 2011, the team detected NPPs-derived ^{134}Cs, ^{137}Cs, and ^{110m}Ag from seawater, zooplankton, euphausiids (shrimp-like crustaceans), jellyfish, and micronektonic fishes.

The results of this research appear in the April 2 online edition of the journal *Proceedings of the National Academy of Sciences of the United States of America* (PNAS).

Introduction

The Great East Japan Earthquake and tsunami of March 11, 2011 resulted in release of radioactive material from the Fukushima Dai-ichi nuclear plants (NPPs) to the Northwest Pacific Ocean. NPP ocean discharge concentrations peaked in early April at more than 50 million times preexisting ocean levels of ^{137}Cs. While considerable efforts have been made to report the concentration of selected radionuclides in the air, soil, and at coastal discharge sites, many uncertainties still remain concerning radionuclide distributions in the Pacific Ocean. In addition, information is still too sparse to evaluate the bioaccumulation processes of those radionuclides through marine food-webs.

Assistant professor Jun Nishikawa and research fellow Hiroomi Miyamoto of the Atmosphere and Ocean Research Institute, University of Tokyo were part of an international team of researchers including members of the Woods Hole Oceanographic Institution and New York State University investigating the horizontal and vertical distribution of gamma-emitting radionuclides in the seawater and zooplankton, euphausiids (shrimp-like crustaceans), jellyfish, and micronektonic fishes in the Pacific Ocean 30-600 km offshore from the NPPs during a June 2011 research cruise of University of Hawaii's research vessel, *Ka'imikai-o-Kanaloa*.

Major Results and Achievements

This study is the first to demonstrate the detection of Fukushima-derived ^{134}Cs and ^{137}Cs throughout waters 30-600 km offshore at relatively low concentrations. The highest ^{134}Cs and

^{137}Cs activities detected in the surface seawater were about 3900 Bq m^{-3} (or 3.9 Bq L^{-1}) for both isotopes, and associated with a near-shore eddy formed at around 36.5˚N, 142˚E, not the nearest location to the NPPs (Figure). This result is consistent with the data from surface drifting recorders and an oceanographic model developed by the researchers. It is evident that the Kuroshio Current forms a southern boundary for the transport of these Fukushima-derived radionuclides, because samples at this boundary or to the south had ^{134}Cs activities < 3 Bq m^{-3}.

Fukushima-derived Cs isotopes were also detected in zooplankton, euphausiids, jellyfish, and mesopelagic fishes. The highest ^{134}Cs and ^{137}Cs activities in zooplankton were about 50 Bq kg^{-1} dry weight and were observed in the Kuroshio Current region. Fukushima-derived ^{110m}Ag was also detected in zooplankton, euphausiids, and jellyfish, but not in micronektonic fishes. The concentration factors–essentially the degree of radionuclides enrichment in biota (Bq kg^{-1} dry weight) relative to ambient seawater (Bq L^{-1})–showed 44 as median value in zooplankton, comparable to the recommended International Atomic Energy Agency (IAEA) value of 40. The concentration factors, however, varied from 10-351, depending on sampling location.

A total inventory of ^{137}Cs in an ocean area of 150,000 km^2 was estimated as about 2 PBq in this study, a value that is consistent with other estimates.

While the concentrations of Cs isotopes exhibited levels 10-1000 times higher than prior levels in waters off Japan, radiation risks due to these gamma-emitting radionuclides were below those generally considered harmful to marine animals and human consumers, and even below those from naturally occurring radionuclides, such as ^{40}K.

This study clarified the large-scale distributions of radionuclides derived from NPPs in seawater and biota at a relatively early point (3 months) after the accident by means of international collaboration, using high-purity germanium spectroscopes that enable measurement with very low detection limits.

Paper information

Journal name: *Proceedings of the National Academy of Sciences of the United States of America* (PNAS)
Title: "Fukushima-derived radionuclides in the ocean and biota off Japan."
Authors: Buesseler, K. O., S. R. Jayne, N. S. Fisher, I. I. Rypina, H. Baumann, Z. Baumann, C. F. Breier, E. M. Douglass, J. George, A. M. Macdonald, H. Miyamoto, J. Nishikawa, S. M. Pike, and S. Yoshida,
DOI：doi/10.1073/pnas.1120794109

Contact to

Jun Nishikawa, Assistant professor, University of Tokyo
jn@aori.u-tokyo.ac.jp
04-7136-6163

Figure is available at:
http://www.aori.u-tokyo.ac.jp/research/news/2012/20120404.html