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Fukushima Accident: Radioactivity Impact on environment, land and ocean

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Radioactive materials were released to the environment from the Tokyo Electric Power Company Fukushima Dai-ichi Nuclear Power Plant (FNPP1) as a result of reactor accidents caused by a total loss of electric power (black out) after the Tohoku earthquake and tsunami on 11 March 2011. Radioactive materials were emitted into the atmosphere and transferred to the land and ocean through wet and dry deposition. In addition, highly contaminated water was directly released to the ocean. Therefore radioactive materials were released to the ocean by two major pathways, atmospheric deposition and direct release from the site.

Regarding with ¹³⁷Cs, ca. 2% of ¹³⁷Cs (15 PBq) of total inventory of the three melt down cores of which total inventory was 700 PBq, were released into the atmosphere then 80 % of atmospheric release were deposited in the ocean. Twenty percent of ¹³⁷Cs (141 PBq) were dissolved in the stagnant water in turbine buildings and surrounding areas by the accident. 0.5 % of ¹³⁷Cs (3.5 +- 0.7 PBq) were directly released in the ocean. Since the ¹³⁴Cs to ¹³⁷Cs activity ratio was almost 1 at the time of the accident, same amount of ¹³⁴Cs were injected in the environment as well as that of ¹³⁷Cs stated above. The total amount of deposited ¹³⁷Cs in Japan was estimated to be 2.9 PBq based on aerial monitoring in Fukushima prefecture and daily deposition monitoring at 50 stations in each prefecture.

The oceans are important sinks of anthropogenic pollutants, such as radionuclides, heavy metals and organic compounds, that are mainly atmospherically derived and/or directly discharged, but there is little information on their overall transport process during several decades after their injection. The bulk of the anthropogenic radionuclide ¹³⁷Cs present in the oceans today was injected about five decades ago from atmospheric nuclear weapons tests and total inventory of ¹³⁷Cs in the North Pacific Ocean was 69 PBq just before the FNPP1 accident. Until the end of 2011, a main body of Fukushima derived radiocaesium were existed at surface layer, however, after winter cooling 2011/2012 we found subsurface maximums of Fukushima derived ¹³⁴Cs and ¹³⁷Cs due to subduction in the subtropical gyre in the North Pacific Ocean. The subsurface maximums corresponded wiith SubTropical Mode Water (STMW) and Central Mode Water (CMW). The water column inventory shallower than 200 meters depth in November 2011 at 40 deg. N, 165 deg. E was 80 % of total, while it decreased 20 % in June 2012.
In winter 2013/2014, 137Cs activity in surface water close to the FNPP1 site is still around 1000 Bq m⁻³ while a maximum of Fukushima derived ¹³⁷Cs in surface water were observed at the eastern part of the North Pacific Ocean and the ¹³⁷Cs activity was a few Bq m⁻³ which is already close to pre-Fukushima level and ¹³⁴Cs activity in surface water was less than 1 Bq m⁻³.

Primary author: Prof. AOYAMA, Michio (Institute of Environmental Radioactivity, Fukushima University)

Presenter: Prof. AOYAMA, Michio (Institute of Environmental Radioactivity, Fukushima University)

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