

Total Amount of Radiocaesium Released into the Environment by Fukushima Dai-ichi Nuclear Power Plant accident

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1. Introduction

- As a result of reactor accidents at the Fukushima Dai-ichi Nuclear Power Plant (FNPP1), caused by a total loss of electric power (black out) after the Tohoku earthquake and Tsunami on 11 March 2011, large amounts of radioactive materials were released to the environment.
- The main long-lived radionuclide released from FNPP1 was radiocaesium, ¹³⁴Cs and ¹³⁷Cs of which activity ratio was ca. 1, therefore the total amount of radiocaesium into the environment is one of the global concerns.
- We estimated the total amount of radiocaesium released into the environment.

2. Our results: Release amount of radiocaesium

One of the greatest results obtained by analyzing seawater samples from the North Pacific Ocean was the estimation of the total amount of ¹³⁷Cs in the North Pacific to be 15-18 PBq. This estimation has been validated by two methods described by Tsubono et al. (2016) and Inomata et al. (2016). Coastal modeling results gave the amount of ¹³⁷Cs direct discharge from the FNPP1 to coastal waters to be 3.5 ± 0.7 PBq which was the first and the most accurate result. Since the amount of direct discharge was accurately determined, the amount of ¹³⁷Cs released into the atmosphere was also properly determined by the mass balance consideration (Aoyama et al., 2016). Results are in Fig.1. We show consensus values and comparison among past releases as Tables below.

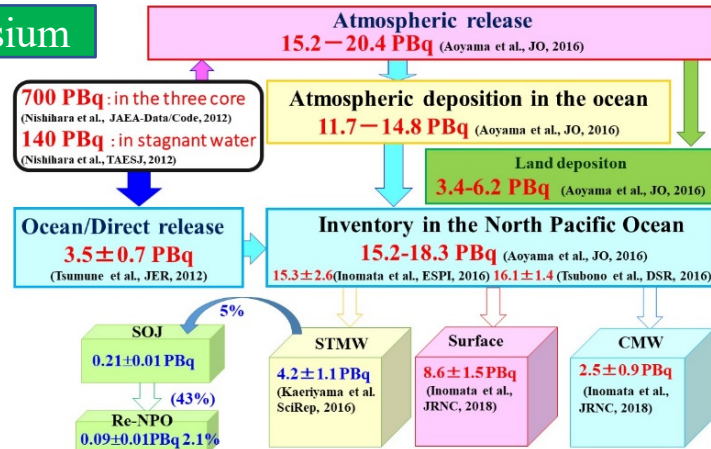


Fig. 1 Final mass balance of released radiocaesium

After injected in the ocean, half of the radiocaesium remained in surface layer while second half of the radiocaesium subducted into the two mode waters (Inomata et al., 2018). On land, most of the deposited radiocaesium stayed and small amount of radiocaesium transported to the ocean (Sakuma et al., this session).

Table 1 Our results and consensus values shown by Aoyama et al., 2020, JER (unit: PBq)

	Total atmospheric release	Atmospheric deposition on land	Atmospheric deposition on the North Pacific	Direct discharge to ocean	Total in the North Pacific
Our results	15.2–20.4	3–6	11.7–14.8	3.5 ± 0.7	15.2–18.3
Consensus	15-21	3-6	12-15	3-6	15-18

Table 2 A comparison among several sources of radionuclides from nuclear accidents and weapons tests. Unit:PBq

source	year	¹³⁷ Cs	¹³⁴ Cs	⁹⁰ Sr	³ H	¹³³ Xe	¹³¹ I
Atmospheric weapons tests (NH only)	1970	765+-79		310	240000		
Windscale	1957	0.044	0.0011	0.00022		14	0.59
Three Mile Island	1979					74-370	0.00056
Chernobyl	1986	85	47	10		6500	1760
Fukushima (to atmosphere)	2011	15-20	15-20	0.01-0.2		11000	160
Fukushima (direct to ocean)	2011	3.5+-0.7	3.5+-0.7	around 1	0.05		20

3. Conclusions: Our estimation of released amount of radiocaesium from the FNPP1 accident in 2011 satisfied mass balance in each domain and then most accurate results. Our results also consistent with several reliable estimates by other scientists who did not use mass balance consideration.