Validation of the Advanced Environmental Transfer and Dose Assessment Model for Radionuclides Released from the Nuclear Fuel Reprocessing Plant in Rokkasho

Hidenao HASEGAWA, Shinya OCHIAI, Hideki KAKIUCHI, Shinji UEDA, Shun'ichi HISAMATSU
Department of Radioecology

Abstract

The first commercial nuclear fuel reprocessing plant in Japan, located in Rokkasho, Aomori Prefecture finished its final testing using actual spent nuclear fuels and is now under safety assessment by the Nuclear Regulation Authority. The advanced environmental transfer and dose assessment model (AdvETDAM) was developed for estimating areal and temporal distributions of the radionuclides around the plant and the radiation doses resulting from these radionuclides. To validate the model using actual field data, we measured the concentrations of radionuclides (^{3}H, ^{14}C, ^{129}I, etc.) in various environmental samples collected at points around the plant and the environmental γ-ray dose rates at IES.

Because no nuclear fuel rods have been sheared or dissolved at the plant since October 2008, concentration levels of the radionuclides in most environmental samples collected in FY 2015 were similar to the background ones before the plant test operation, excluding several samples. Iodine-129 deposited on soil and lake sediment surfaces around the plant has still remained at a higher level than each background level.

Since the accident at the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) in 2011, we have studied the distribution and transfer of several radionuclides in Fukushima Prefecture to clarify their movement in the terrestrial environment. The obtained results will be used to improve the accuracy of the model prediction in AdvETDAM. In FY 2015, we studied the following subjects: 1) the distribution of ^{3}H in plant and soil samples collected around the FDNPP, 2) the discharge rate of radiocesium via two small rivers in a mountainous area in Iitate Village, and 3) the re-suspension rate of radiocesium in Namie Town and Koriyama City.

Free-water tritium (FWT) concentrations in plant samples collected in Fukushima Prefecture have been gradually decreasing from 2011 to 2015. The effective half-life of FWT in those were estimated as a few days for a week after the accident, and as 1 to 2 months from 1 week after the accident until August 2011. The discharge rate of radiocesium from the river catchments of the two small rivers during 2015 was less than 1% of radiocesium deposited in the catchments, showing that most of the radiocesium has still remained on the soil surface in the catchments. The atmospheric ^{137}Cs concentration showed a clear seasonal fluctuation with high values during summer and autumn in Namie and with high values during winter and spring in Koriyama. We defined the wind direction-weighted mean ^{137}Cs deposition densities, which was a sum of the products of the frequency of wind direction for a month and the ^{137}Cs deposition density in each sector of 16 directions in a 5 km radius, and the wind direction-corrected resuspension factor, which was the quotient of atmospheric ^{137}Cs concentration divided by the wind direction-weighted mean ^{137}Cs deposition densities. The range of the re-suspension factor of ^{137}Cs (Namie, 4×10^{-11} to 8×10^{-10}; Koriyama, 8×10^{-11} to 1×10^{-8}) was similar to the annual mean resuspension factor, which was defined as the quotient of atmospheric ^{137}Cs concentration divided by local ^{137}Cs deposition densities, observed at Chernobyl and in European countries (1×10^{-10} to 1×10^{-6}). In addition, our re-suspension factor has been gradually decreasing with an effective half-life of approximately 1 year.

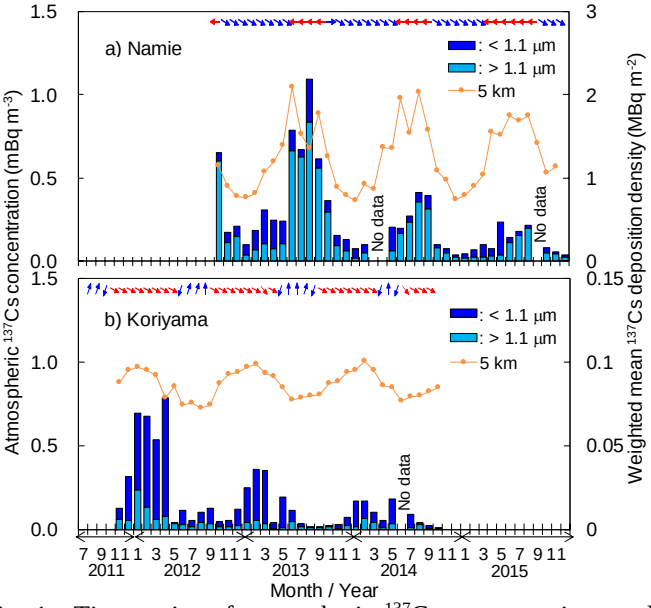

Fig. 1 Time series of atmospheric ^{137}Cs concentrations and wind direction-weighted mean ^{137}Cs deposition densities, which was a sum of the products of the frequency of wind direction for a month and the ^{137}Cs deposition density in each sector of 16 directions in a 5 km radius. Blue and light blue bars indicate ^{137}Cs concentrations in particulates <1.1 μm and >1.1 μm, respectively. (a) Namie Town and (b) Koriyama City. Arrows indicate the most frequent wind direction in a month.

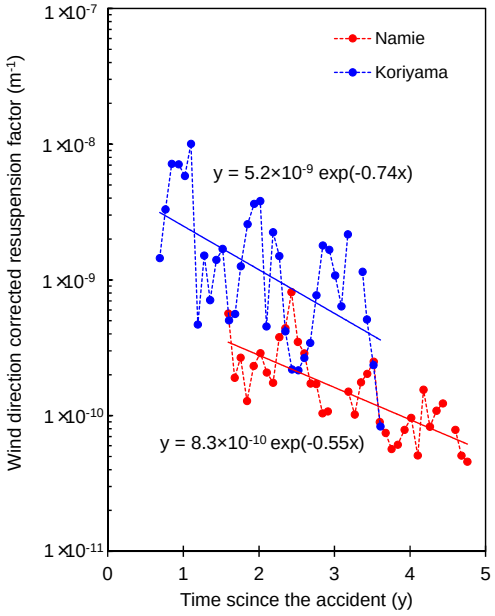

Fig. 2 Time series of wind direction-corrected resuspension factor, which was the quotient of atmospheric ^{137}Cs concentration divided by the wind direction weighted mean ^{137}Cs deposition densities, during study period in Namie Town and Koriyama City.