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

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Abstract

We have developed the advanced environmental transfer and dose assessment model (AdvETDAM) for radionuclides released from the first Japanese commercial nuclear fuel reprocessing plant located in Rokkasho. To describe the radionuclides transfer in each target sphere, the AdvETDAM consists of: an atmospheric dispersion model with a mesoscale meteorological model (MM5), a terrestrial transfer model, aquatic transfer models for Lakes Obuchi and Takahoko, which are brackish lakes neighboring the reprocessing plant, and their catchment areas, and a coastal marine model for the Rokkasho coast.

To improve accuracy of simulation by the atmospheric dispersion model, four data assimilation procedures, which were designed in FY 2016 and introduced in FY 2017, were evaluated in FY 2018. The assimilation procedures were applied to wind field calculations in the mesoscale meteorological model and the dispersion model. In addition, we tried to improve the Lagrangian particle dispersion calculation by three approaches: 1) modifying averaged atmospheric ^{3}H discharge rates from the main stack for every ~1 week to discharge rates different in each day to represent well the atmospheric ^{3}H concentrations measured around the main stack, 2) modifying plume raise height using ^{85}Kr concentrations measured around the main stack and 3) estimating mixing height based on data measured by a ceilometer at our institute. The evaluation results showed that the data assimilation in the wind field calculations and approach 1) were effective, giving simulation results closer to the measured ones with the assimilations. Although approaches 2) and 3) were not effective for estimating ^{85}Kr concentrations, approach 3) was considered to provide reasonable mixing heights based on the measured data.

To assess uncertainties of results by the AdvETDAM, the probabilistic assessment function for exposed dose was designed in FY 2018, and it will be introduced in FY 2019. The uncertainty analysis of simulation results for accidental discharges was designed by referring to the level 3 probabilistic risk assessment for a nuclear power plant, while that for discharge under normal operation was also roughly designed.

For realistic simulation of ^{14}C and ^{3}H transfers from the atmosphere to agricultural products in the terrestrial transfer model, the dynamic transfer models developed in our previous studies were introduced for the ^{14}C transfer, while the ^{3}H transfer in the same routes was designed in FY 2018. In addition, to simulate radionuclide transfers in the Lake Obuchi model and Rokkasho coastal model over a year, a restart function was installed in those models.

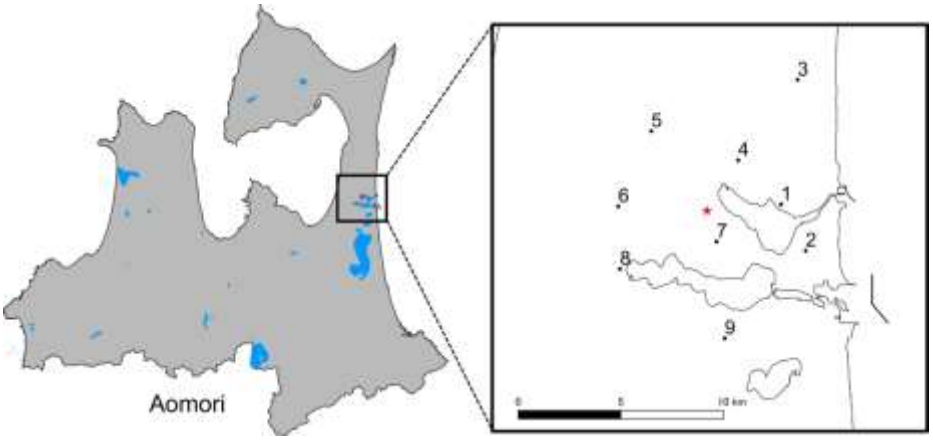
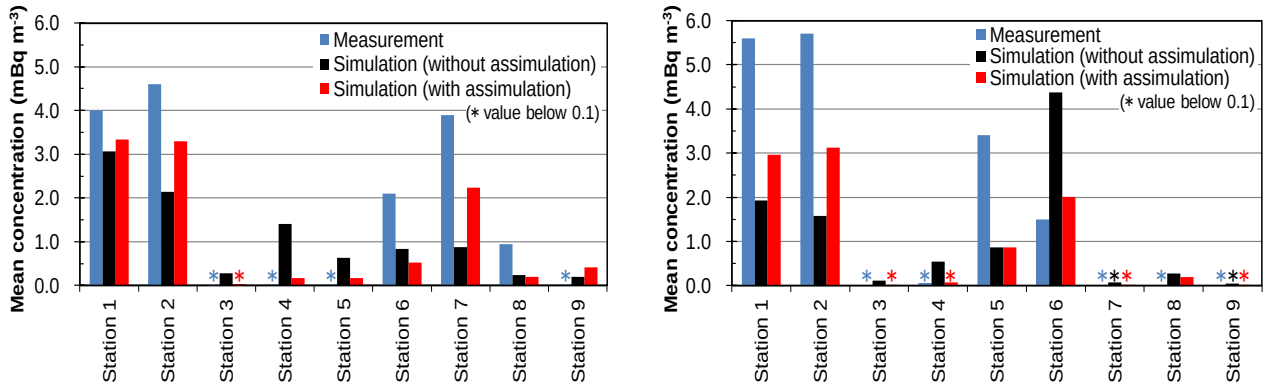


Fig. 1 Location of measurement stations. There are 9 measurement stations including No. 1 located at IES and No. 2 located at AMBIC. The star marks location of the plant main stack.



(a) November 2007 (b) September 2008

Fig. 2 Masurement and simulation values of atmospheric ^{3}H concentrations during the final test operation of the nuclear fuel reprocessing plant using actual spent fuel in November 2007 and September 2008. Blue, black and red bars denote mesurement value, and simulation values with assimulation and without assimulation, respectively.