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) radionuclides released from the first Japanese commercial nuclear fuel reprocessing plant located in Rokkasho. The computer code system was developed on personal computers to describe atmospheric dispersion, terrestrial and aquatic transfers, and dose calculations for the released radionuclides. The model consists of an atmospheric dispersion model with a meteorological model (MM5), a terrestrial transfer model, an aquatic transfer model for Lake Obuchi, which is a brackish lake neighboring the reprocessing plant, and its catchment area, and a coastal marine model for the Rokkasho coast.

In FY 2014, to develop an aquatic radionuclide transfer model for Lake Takahoko, which is another brackish lake near the reprocessing plant, and its catchment area, hydrological models were constructed to describe water movement in the target areas. The hydrological data, including the water currents, the flux of sedimentation matter and the submarine groundwater discharge rates were collected from Lake Takahoko to construct the hydrological model. To construct the hydrological model for the Lake Takahoko catchment area, hydrological data of water levels and residence time of groundwater, were collected in that area.

The Coastal Sea Modeling System for Hydrodynamic Processes (COSMOS) was adopted to simulate water currents in Lake Takahoko, and numerical results obtained by the model for water current and salinity were compared to the observed data. Also, the Water and Energy Transfer Process (WEP) model was adopted to simulate water transfer in the catchment area in Lake Takahoko, and numerical results for river water discharge and water level of ground water were in a good agreement with field measurements. Radionuclide transfer models will be added to the hydrological models in FY 2015.

In FY 2014, we modified the atmospheric dispersion model of radionuclides to improve accuracy of simulated radiation dose and atmospheric concentration of ^{85}Kr released from the reprocessing plant. The accuracy of the dose and concentration was considerably improved by modifying several equations including stochastic equations for the Random Displacement Method and transform factors for the vertical axis. In addition, we wrote an interface program for using the Rader AMeDAS precipitation data, which have been analyzed and published by the Japan Meteorological Agency, as input to the atmospheric dispersion model for better prediction of the washout process of radionuclides.

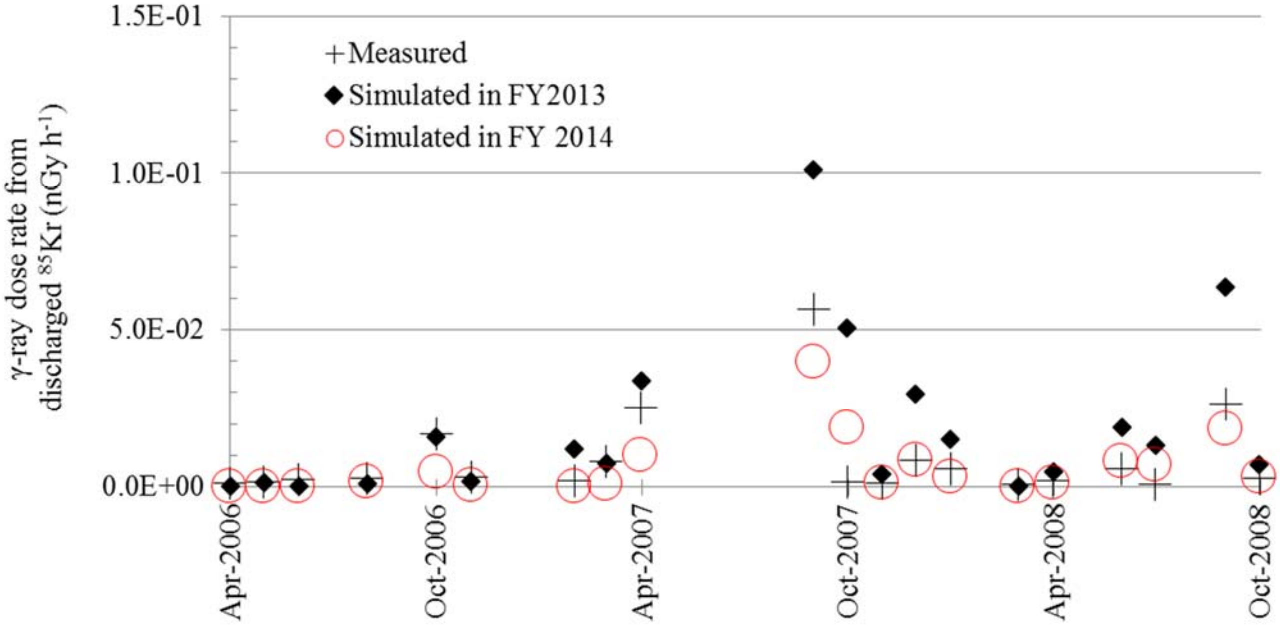

Fig. 1 Monthly averaged γ-ray dose rate from discharged ^{85}Kr during the period from April 2006 to October 2008.

Table 1 Consistency between simulated and measured monthly averaged concentrations and depositions for ^{3}H and ^{129}I evaluated by Mean Errors (ME) and Root Mean Square Errors (RMSE) during the period from April 2006 to February 2009.

	Measured average	FY 2013		FY 2014	
		ME (Bq m^{-3})	RMSE (Bq m^{-3})	ME (Bq m^{-3})	RMSE (Bq m^{-3})
^{3}H concentration (Bq m^{-3})	2.3×10^{-3}	3.3×10^{-3}	6.7×10^{-3}	-1.2×10^{-3}	2.7×10^{-3}
^{3}H deposition (Bq m^{-2} month^{-1})	9.7×10^{0}	2.3×10^{1}	4.8×10^{1}	2.9×10^{0}	2.1×10^{1}
^{129}I concentration (Bq m^{-3})	1.8×10^{-8}	4.0×10^{-4}	2.0×10^{-4}	4.1×10^{-8}	9.9×10^{-8}
^{129}I deposition (Bq m^{-2} month^{-1})	9.8×10^{-4}	9.4×10^{-1}	4.7×10^{-1}	-7.6×10^{-4}	1.7×10^{-3}