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. The computer code system was developed on personal computers to describe atmospheric dispersion, terrestrial and aquatic transfers, and dose calculations for the released radionuclides. AdvETDAM consists of an atmospheric dispersion model with a meteorological model (MM5), a terrestrial transfer model, an aquatic transfer model 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 the simulation results, the data assimilation approach in the atmospheric dispersion model was designed in FY 2016. It was planned to introduce data assimilation into three steps in the dispersion model: a wind field generation step in the mesoscale meteorological model, a mass-consistent 3D wind field generation step for a narrow area, and a final Lagrangian particle dispersion step. Both wind field generation steps were redesigned to assimilate the measured wind direction and velocity, while the basic design was achieved for the assimilation of the measured radionuclides concentration in the dispersion step.

In addition, new modules for estimation of dose by consuming aquatic products obtained from the coast and the lakes in Rokkasho and by drinking well water, were implemented into AdvETDAM. For timely calculation of atmospheric dispersion of radionuclides, the interface for getting meteorological data on line was installed in parallel with the previous interface for optical media, which can be available for months afterwards.

Meteorological model (MM5)

Input: Result of the Japan Meteorological Agency Meso-Scale Model
(holizontal scale is 5 km).
Output: Meteorological field (holizontal scale is 1 km).
+ Data assimilation (1)

Atmospheric dipersion model

Mass-consistent 3D wind field module

Input: Result of the meteorological model.
Output: Wind field (holizontal scale is 500 m).
+ Data assimilation (2)

Lagrangian particle dispersion module

Input: Result of the wind field.
Output: Concentration and deposition of radionuclides.
Calculation:
・Plume rise height   ・Advection
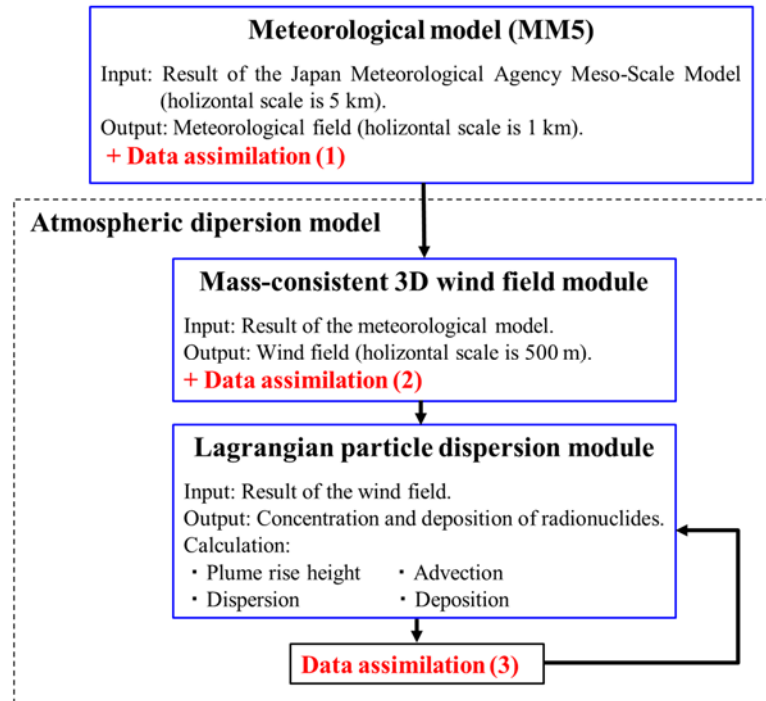・Dispersion   ・Deposition

Data assimilation (3)

Fig. 1   Basic design for AdvETDAM modification in order to assimilate measured data of radionuclide concentrations in the atmosphere, wind speed and direction.

Atmospheric dispersion model

Terrestrial transfer model

Radionuclides released in the air

Deposition

Humify, Root absorption, etc.

Soil

Plant

Ingestion

Animal products

Deposition

Harvest, Storage

Feed

Ingestion

Harvest, Storage

Agricultural products

Cooking, Ingestion

Cooking, Ingestion

External and inhalational radiation exposure

Deposition

Catchment area of Lake Obuchi

Well water ingestion

Inflow

Lake Obuchi model

Lake water in Lake Obuchi

Transfer

Aquatic products

Cooking, Ingestion

Lake Obuchi catchment area model

Inflow, Outflow

Rokkasho Coast model

Radionuclides released in ocean

Inflow

Sea water in Rokkasho Coast

Transfer

Aquatic products

Cooking, Ingestion

Lake Takahoko catchment area model

Inflow, Outflow

Lake water in Lake Takahoko

Transfer

Aquatic products

Cooking, Ingestion

Catchment area of Lake Takahoko

Inflow

Lake Takahoko model
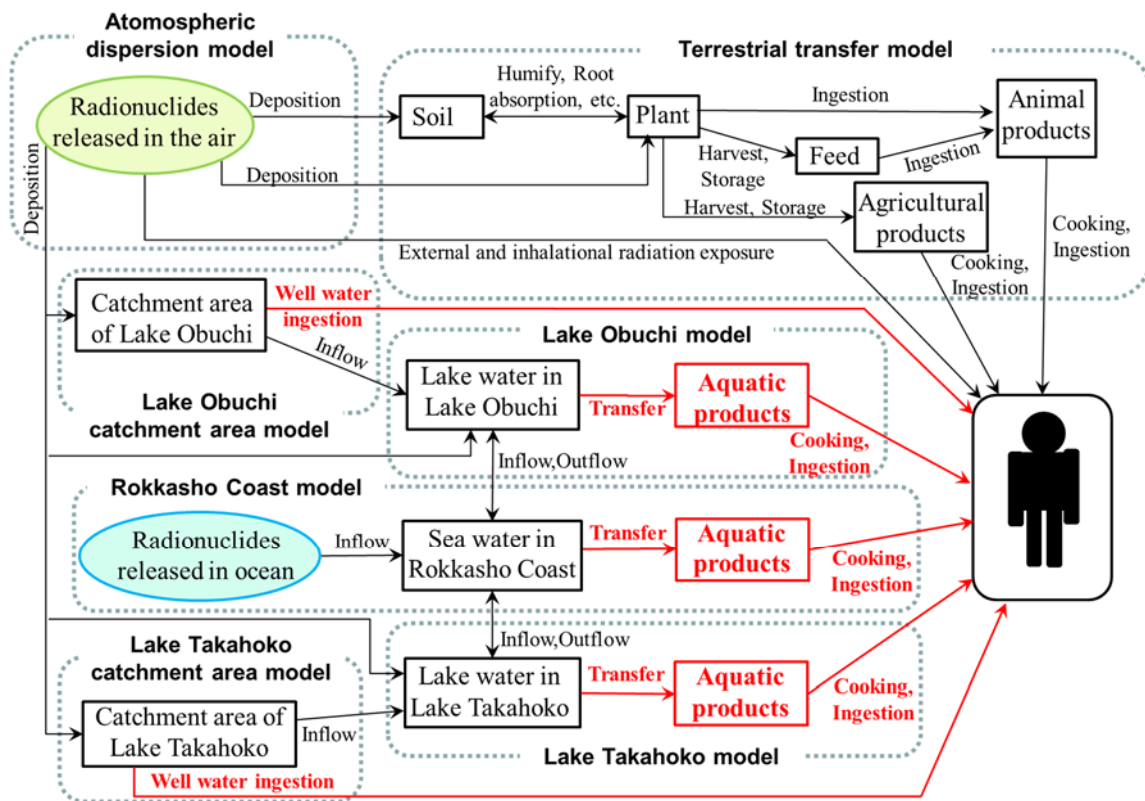
Well water ingestion

Fig. 2   Transfer paths of radionuclides in AdvETDAM after adding evaluation of dose from aquatic products and well water. Red lines and boxes show the additions in FY 2016.