Preliminary estimation of radioactive cesium concentration due to hypothetical accident in East Sea

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1. Introduction

The East Sea is a marginal sea of the western Pacific Ocean, between the Korean Peninsula, the Japanese archipelago and Sakhalin. It is bordered by Japan, North Korea, Russia and South Korea. Like the Mediterranean Sea, it has almost no tides due to its nearly complete enclosure from the Pacific Ocean. The sea has no large islands, bays or capes. Its water balance is mostly determined by the inflow (Korea Strait) and outflow (Tsugaru Strait and Soya Strait) through the straits connecting it to the neighboring seas and Pacific Ocean.

All of the Korean nuclear power plants are located in the coastal area, 3 sites in the east coast and 1 site in the west coast. So the Korean nuclear power plants there may be possibility that such dangerous substances spread out of the East Sea. The East Sea is a fertile fishing ground for surrounding counties. The environmental radionuclides concentration estimation is important for fish and sea plants may be contaminated by those radioactive materials.

2. Material and Methods

2.1. LORAS code

An oceanic dispersion model named LORAS (Lagrangian Oceanic Radiological Assessment System) has been developed by Korea Atomic Energy Research Institute to evaluate the transport characteristics of the radionuclides released into the sea for a nuclear accident [1].

The model was designed to calculate radionuclide concentrations in seawater, suspended matter and seabed sediments in time and space using a particle tracking method. The particle tracking technique has some advantages over finite difference methods. In particular, numerical diffusion is not introduced and the exact position of the release point may be specified. Thus, it is not necessary to assume that the discharge is instantaneously mixed into a grid cell of a given size. A passive particle is transported by current components and dispersed by turbulent motion. Currents are supplied by the hydrodynamic circulation model and turbulent dispersion is evaluated using a random walk method [1, 2].

2.2. Hydrodynamic Model

JCOPE2 (Japan Coastal Ocean Predictability Experiment) has been developed by JAMSTEC (Japan Agency of Marine-Earth Science and Technology). It is based on one of the world community models, Princeton Ocean Model. Open boundary conditions are obtained from a global scale circulation model with lower resolution, using a one-way nesting procedure.

JCOPE2 consists of 23 vertical levels and spatial resolution is about 9 km. The model is driven by wind stresses, and heat and salt fluxes. The wind stress and heat flux field are calculated from the 6-hourly NCEP Global Forecast system data using bulk formulae. The salinity at the surface is restored to the monthly mean climatology with a time scale of 30 days.

The output of JCOPE2 is used for ship routing of oil tankers, fishery and drilling ships. It has also been already applied to simulate the dispersion of Fukushima releases in the Pacific [1].

The source term of hypothetical accident applied the same direct release scenario of the Fukushima accident estimated by Kobayashi et al. [3]. This source term estimation leads to a total 137Cs release of 3.5PBq from March 26th to June 30, 2011. Hypothetical accident was assumed at Hanul nuclear power plant.

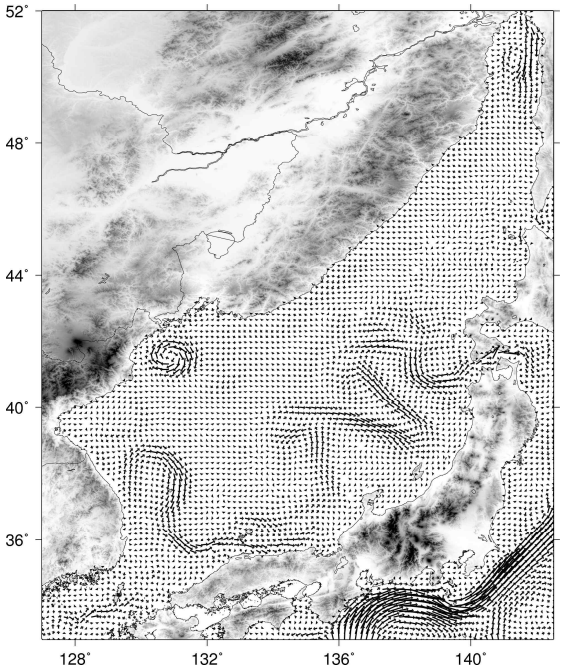
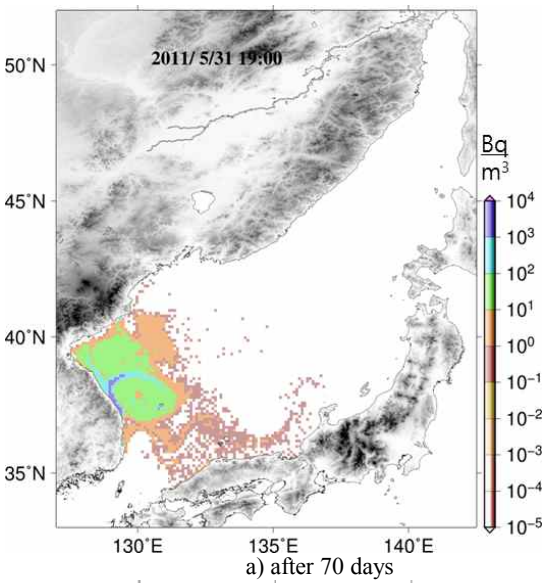


Fig. 1. Estimation area and ocean currents in the sea surface for March calculated by JCOPE model.

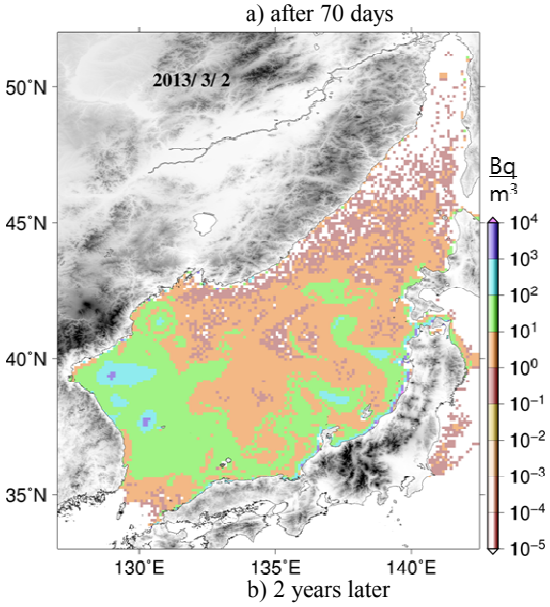
3. Results and Discussion

3.1. Cesium Dispersion

Figure 2 shows the concentration (Bq/m^3) of Cs-137, even after a long time a relatively high concentration is maintained in the near east coast of Korean Peninsula because the great vortex nearby Ulleung Plateau prevents the spread of radioactive cesium (Fig. 1). Some of released cesium seems to be transfer to the Tsugaru Strait along the East Korea Warm Current.



a) after 70 days

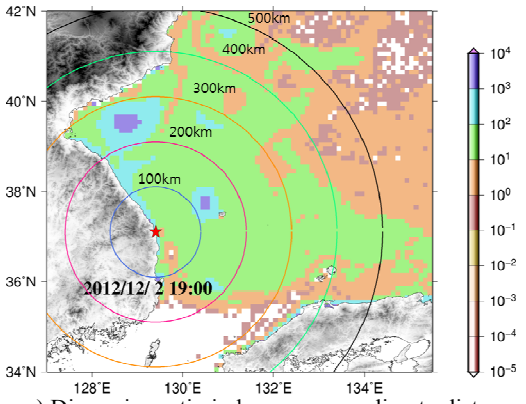


b) 2 years later

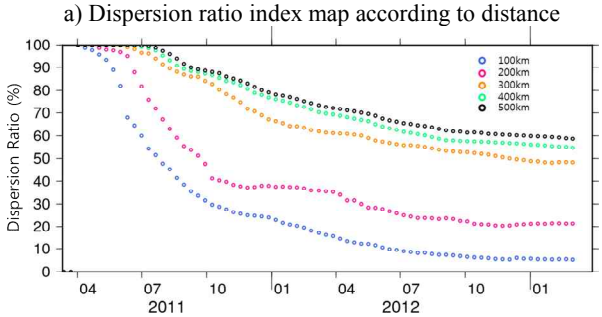
Fig. 2. Concentration in the sea water due to hypothetical Hanul NPP scenario

3.2. Dispersion Ratio

Figure 3 shows the dispersion ratio in the East Sea. The dispersion ratio is the ratio of the remaining amount of the total emissions within the specific area. The area of 200km radius corresponding to the fishing zone of Republic of Korea in East Sea in figure 3. Dispersion ratio in this region tends to be maintained at about 20% at the last two years after the hypothetical accident.



a) Dispersion ratio index map according to distance



b) Dispersion ratio according to distance

Fig. 3. Dispersion ratio in the East Sea

4. Conclusions

In order to simplify the problem, the experiment has been considered the many simplifying assumptions. The bed sediments are uniform over all the model domain, using the monthly mean ocean current data set and ignored effect of the facilities for damage preventions. The results shown here is part of an ongoing research, the more detailed assessment will perform.

ACKNOWLEDGEMENT

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