Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 29-30, 2009

Oceanic Diffusion Coefficient around Wolsong Nuclear Power Plant Site

Gab-Bock Lee, Yang-Geun Chung, Yang-Hee Yang
Korea Electric Power Research Institute, KEPCO, 103-16 Munji-Dong, Yuseong-Gu, Daejeon 305-380, Korea
gblee@kepco.co.kr

1. Introduction

In Korea, total 20 units of nuclear power plants have been operated at 4 sites - Kori, Ulchin, Wolsong and Yonggwang. At present, 10 units of new nuclear power plants have been under construction or planed at Kori, Wolsong and Ulchin sites. In the near future, more than 20 units of nuclear power plants will be intensively operated at the east coast of Korea.

Recently, to more accurately assess the radiological impact of radioactive effluents in relation to the new nuclear power plant siting, the license renewal, and the normal operation, three-dimensional models have been developed and used for aquatic dispersion[1)] based on the Notice No. 2008-9 "Guideline for investigating and assessing hydrological and aquatic characteristics of nuclear facility site" of the Ministry of Education, Science and Technology (MEST) in Korea.

In this study, the oceanic diffusion coefficients used in these models were estimated by using drifters/buoys with GPS around Wolsong nuclear power plant site in 2005 and 2008.

2. Methods and Results

2.1 Model Overview

For assessing the aquatic dispersion of radioactive effluents near the east coastal region of Korea, it is necessary to know the circulation of the water mass in the East Sea.

Modeling system consists of 3 phases. At 1st phase, the circulations of East Sea were modeled, which encompassed large parts of the East Sea (phase 1), then nested smaller scale model was used for local and more detailed simulations (phase 2). Finally, the dispersions of liquid effluents within 15km from discharges of Wolsong plants were modeled by using the phase 3 model. The model domains are illustrated in Fig. 1.

The Phase 1 model was based on the RIAMOM (Research Institute of Applied Mechanics' Ocean Model, Kyushu University, Japan), which has been proven to be applicable to the simulation of the East Sea/Japan Sea circulation.[2)] The model uses primitive equation with hydrostatic approximation, and uses Arakawa-B grid system horizontally and Z-coordinate vertically.

The model domain covers the area between 126.5°E and 142.5°E, and 33°N and 52°N. The grid intervals are 1/12° in longitudinal and latitudinal directions and vertical levels is divided into 20. This model uses generalized Arakawa scheme, slant advection, and mode-splitting method.

The input data were obtained from JODC (Japan Oceanographic Data Center), KNFRDI(Korea National Fisheries Research and Development Institute), and ECMWF (European Center for Medium-Range Weather Forecasts).

The local scale model (phase 2) simulated the hydrodynamics and radionuclide dispersion in the coastal region outside 80km from the plant sites. The input data and boundary conditions were provided by the results of the Phase 1 model with one-nesting scheme.

The dispersions of the liquid radioactive effluents around Wolsong site were modeled by using the EFDC (Environmental Fluid Dynamics Code) developed by VIMS(Virginia Institute of Marine Science).[3~4)] Model domain is illustrated in Fig. 1. The input data and boundary conditions are provided by the results of the Phase 2 model with one-nesting scheme.

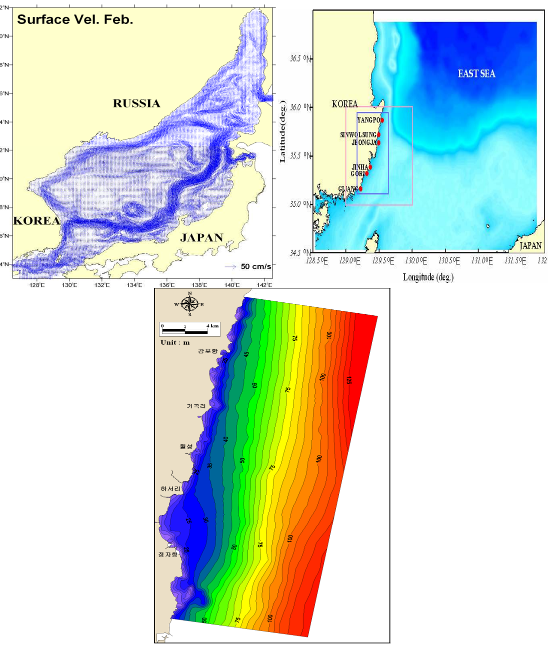

Fig. 1. Model Domains of phase 1(top:left), phase 2(top:right), and phase 3(bottom).

2.2 Oceanic Diffusion Coefficient

The background horizontal diffusion coefficient of phase 2 model was determined by using ARGO drifters in October 2005 around Wolsong site.[5)] 3 drifters were dropped at a 3km distance from discharge of Wolsong NPP. The background horizontal diffusion coefficient of phase 3 model was determined by using buoy with GPS in December 2008. 3 buoys per point were launched at 3 points (0.5, 1, 1.5km from discharge, respectively).

The launching time and points of drifters and buoys are illustrated at Table 1. The trajectories of drifters and buoys are illustrated in Fig. 2 add Fig. 3

Table 1. Launching Time and Points of Drifters/Buoys

	NO.	point		Launching time
		Lon.	Lat.	
ARGO drifter	56678	129°E 30’43.2”	35°N 43’24.9”	2005.11.21 14:00
	56769			
	56730			
Buoy	B1	129°E 29’3.2”	35°N 43’1.1”	1)2008.12.11 11:00
	B2	129°E 29’20.9”	35°N 43’0.0”	2)2008.12.12 09:00
	B3	129°E 29’39.8”	35°N 42’58.5”	3)2008.12.13 10:00

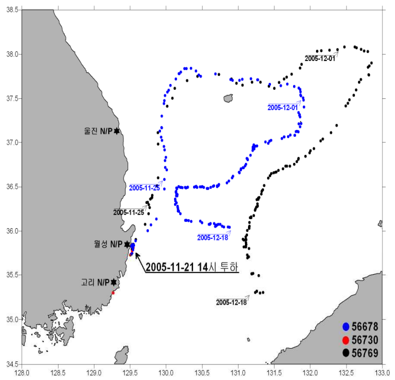

Fig. 2. Trajectories of ARGO Drifter in 2005.

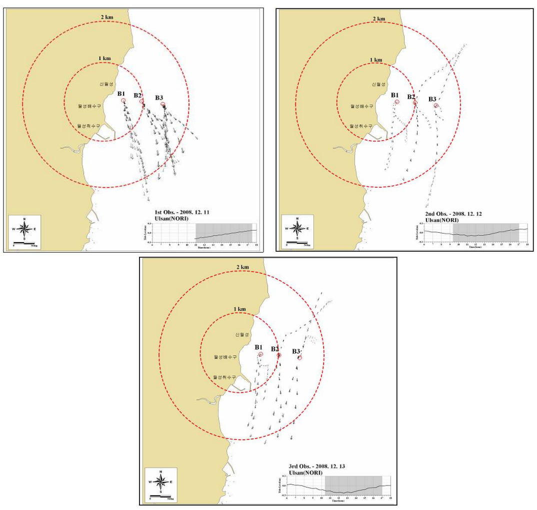

Fig. 3. Trajectories of Buoys in 2008.

The horizontal diffusion coefficient (K_a) is calculated by using the following equations.

$$\sigma^2_{rc} = 2\sigma_x \sigma_y \qquad K_a = \sigma^2_{rc}/4t$$

Where, σ_x is distance of x-direction, σ_y is distance of y-direction, and t is time.

The horizontal diffusion coefficient obtained from the experiment carried out in 2005 was $3.2\times10^6 cm^2/s$ within 80km from Wolsong NPP.

However, the horizontal diffusion coefficient obtained from the experiment carried out in 2008 was $2.9\times10^4 cm^2/s$ within 2km from the discharge of Wolsong NPP.

The diffusion coefficient around the discharge of Wolsong NPP was smaller than that of phase 2 model domain. This may be caused by the lower current velocity around the discharge.

3. Conclusion

The oceanic diffusion coefficients estimated by using drifters/buoys with GPS around Wolsong nuclear power plant site in 2005 and 2008. The results of this study will be used in 3 dimensional models to estimate the dilution factor for off-site dose calculation during normal operation of NPP.

REFERENCES

[1] Y.G. Chung, G.B. Lee, S.Y. Bang, Development of Radioactive effluent dispersion model, Final report, Korea Electric Power Research Institute (2006) (in Korean).

[2] H.J. Lee, J.H. Yoon, H. Kawamura, H.W. Kang, Comparison of RIAMOM and MOM in modeling the East Sea/Japan Sea circulation, Ocean and Polar Res., **25**(3) (2003) 287-302.

[3] J.M. Hamrick, Linking hydrodynamic and biogeochemical transport models for estuarine and coastal waters, Estuarine and Coastal Modeling, Proceedings of the 3rd International Conference, M. L. Spaulding et al, Eds., American Society of Civil Engineers, New York (1994) 591-608.

[4] J.M. Hamrick, A three dimensional environmental fluid dynamics computer code: Theoretical and computational aspects, The College of William and Mary, Virginia Institute of Marine Science, Special Report-317 (1992).

[5] G.B. Lee, S.Y. Bang, Y.G. Chung, H.R. Lee, S.Y. Nam, Observation of oceanic diffusion coefficient for assessing radiological dose around nuclear power plant sites in Korea, Proceedings of the Spring Meeting of Korean Association for Radiation Protection, 2006.05.11-05.12, Suanbo, Korea (2006) (in Korean).