4–9 Improved Capability for Atmospheric Dispersion Simulation

— Enhancement of Prediction Performance of WSPEEDI-II for Middle-Range Scale Dispersion using Krypton-85 Measurement Data —

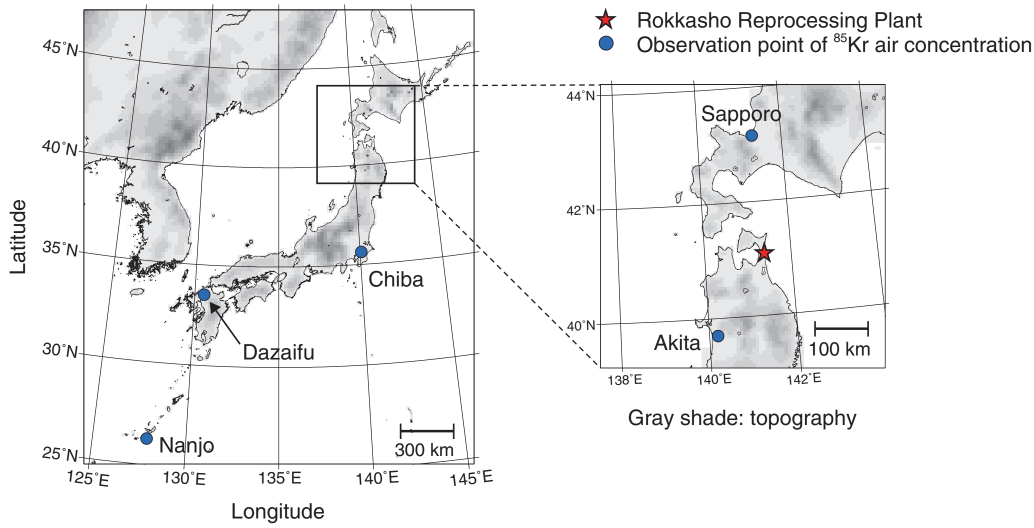

Fig.4-22 Calculation areas and observation points of air concentration of ^{85}Kr
Atmospheric dispersion simulations were conducted using the ^{85}Kr release data provided by Japan Nuclear Fuel Limited for the area including the whole of Japan (Left) and that around RRP (Right) with spatial resolutions of 18 and 6 km, respectively. Observation of the ^{85}Kr air concentrations was performed by the Japan Chemical Analysis Center.

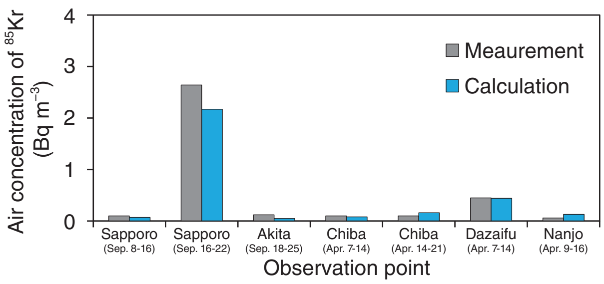

Fig.4-23 Simulation result of the air concentration of ^{85}Kr by WSPEEDI-II
Measured weekly mean surface air concentrations of ^{85}Kr were reproduced by calculation with the modified GFD. Observation periods in 2008 are listed in the brackets following the names of observation points. The measurements show the increases from the background levels.

When radioactive materials are discharged into the atmosphere due to nuclear accidents, atmospheric dispersion simulations are very important for the understanding of the distributions of released radioactive materials and planning of environmental monitoring and countermeasures for the radiation protection of the public. Simulations are conducted over a wide-range of areas from the immediate vicinities of accident sites to regions far distant from them, depending on the magnitudes of the accidents. Then, model parameters that can appropriately simulate various phenomena depending on the scale of the objective area are important for precise simulations. Diffusive effects due to wind turbulence are typically expressed by diffusion coefficients in atmospheric dispersion models. The horizontal diffusion coefficient by Gifford (1982) (hereafter, GFD) is usually used for long-range dispersion with a horizontal distance of several thousand km. However, there have been few verification studies of GFD for middle-range scale dispersions over distances of several hundred km.

In this study, we verified the performance of the second Worldwide version of System for Prediction of Environmental Emergency Dose Information (WSPEEDI-II) for middle-range scale dispersion by dispersion analysis of krypton-85 (^{85}Kr), which was released in test operations at the Rokkasho Reprocessing Plant (RRP) in Aomori Prefecture, Japan using GFD. Air concentrations of ^{85}Kr were observed at several sites in Japan to understand the background level (Fig.4-22). The observation detected the ^{85}Kr discharged from RRP at locations 200–2000 km away. Since ^{85}Kr is a nonreactive gas with a half-life of 10.76 years and the release point is known, the observation data are particularly useful for the verification of diffusion processes.

WSPEEDI-II reproduced weekly mean surface air concentrations of ^{85}Kr with errors ranging between 0.5 and 2 times as much as the measurements. However, from a sensitivity analysis of the horizontal grid distances (resolution) of the meteorological model ranging from 2 to 54 km (used for local- to global-scale simulations), it was found that as the simulated grid resolution became higher, the calculated concentrations became lower than the results using the 54 km resolution. It is believed that the concentrations around the distribution center were underestimated because diffusive effects explicitly represented by grid-resolved wind fields may have been considered redundantly by GFD when using meteorological fields with relatively high grid resolutions. On the basis of the sensitivity analysis, an empirical modification method for GFD according to the grid resolution was proposed. This method improved the reproducibility of concentrations in the middle-range scale, and the result showed the usefulness and validity of this method (Fig.4-23). Using the diffusion coefficients modified by this method, the problem of calculated concentrations varying depending on the selected grid-resolution was remedied, and dispersion simulations that are consistent from local- to global-scales became possible.

Reference

Terada, H. et al., Validation of a Lagrangian Atmospheric Dispersion Model Against Middle-Range Scale Measurements of ^{85}Kr Concentration in Japan, Journal of Nuclear Science and Technology, vol.50, issue 12, 2013, p.1198–1212.