ACHIEVEMENT AND TECHNOLOGY OF NUCLEAR ACCIDENT CONSEQUENCE ASSESSMENT SYSTEM IN CHINA

PENGBO LI[1], HONGWEI YANG[1], GUOQING ZHANG[2], SHA HUANG[3]

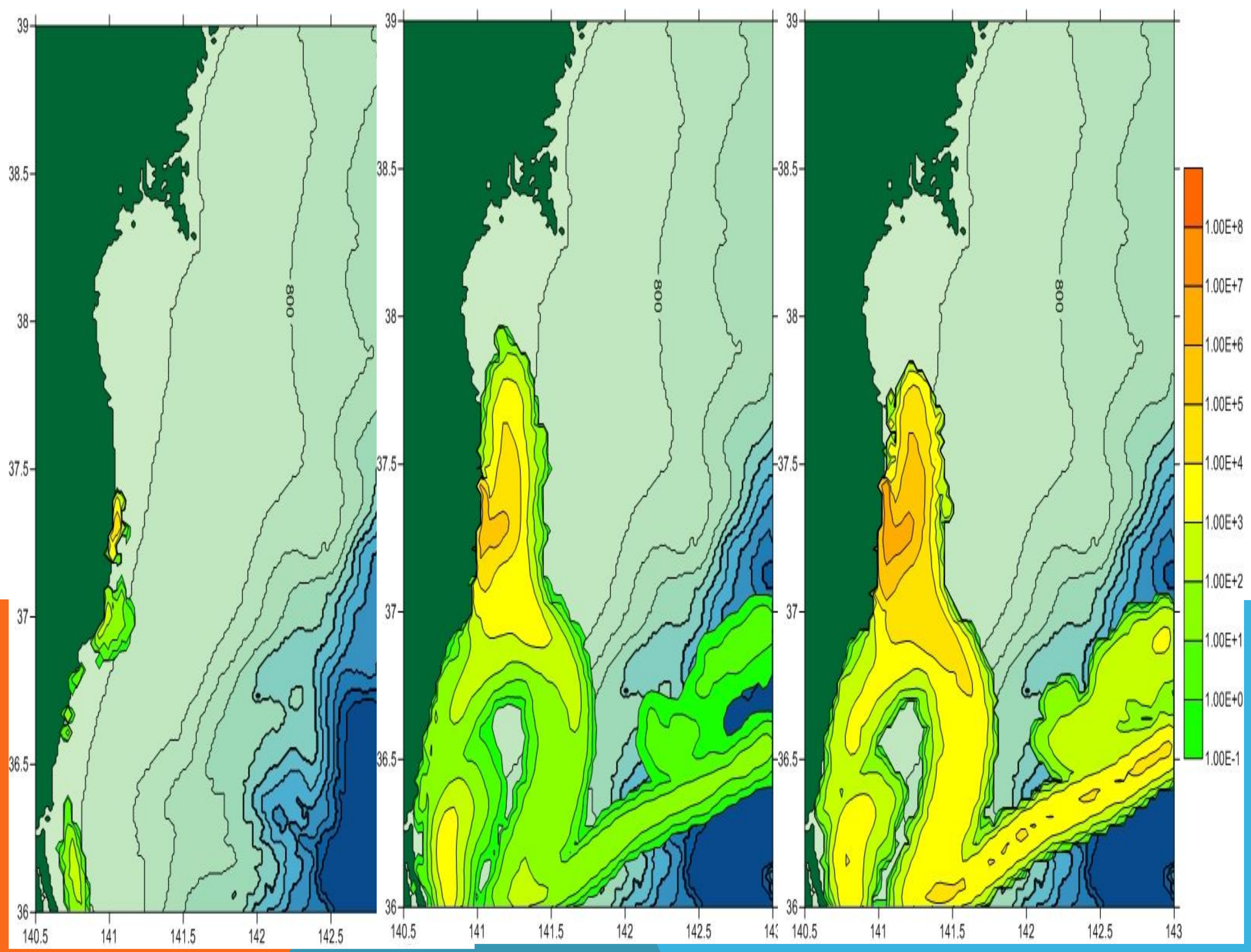
1 CHINA INSTITUTE OF ATOMIC ENERGY, BEIJING 102413, CHINA
2 SHANGHAI INSTITUTE OF APPLIED PHYSICS, CHINESE ACADEMY OF SCIENCES, SHANGHAI 201800, CHINA
3 CHINA INSTITUTE FOR RADIATION PROTECTION, TAIYUAN 030006, CHINA

China Intitute of Atomic Energy (CIAE), founded in 1950, is the cradle of nuclear science and technology in China, and also a comprehensive R&D base which maintains a leading, fundamental and forward looking position in nuclear field. Over the past 60 years, CIAE has become a multi-disciplinary scientific research institute involving nuclear physics, nuclear chemistry and radiochemistry, reactor engineering technology, accelerator technology, nuclear electronics and detection technology, isotope technology, radiation metrology, nuclear safeguards technology, and radiation protection technology.

Department of Radiation Safety & Research is a comprehensive research entity involving the technical R&D on routine monitoring and radiation safety, mainly undertakes the fundamental research associated with nuclear environment and radiation protection, such as environmental impact assessment of nuclear facility, energy and environment, radiation protection and monitoring, nuclear accident, anti-terrorist detection and emergency, radiation effect foundation, and also carries out relevant technical services and civilian product development. For more details: http://www.ciae.ac.cn.

1.China Nuclear Accident Consequence Assessment and Decision-making Support System

	Name	Capacity	Development by	Application
1	Nuclear Accident Consequence Assessment System	Wind field forecast; Atmosphere diffusion model; Dose evaluation and partition	Tsinghua University	Liaoning province, Hongyanhe NPP
2	Nuclear Accident Consequence Assessment and decision-making support System	Wind field forecast; Atmosphere diffusion model (Lagrange stochastic particle model); Dose evaluation and protection action partition	Departure of Radiation Safety Research,China Institute of Atomic Energy	CIAE
3	NAOCAS (Nuclear Accident of offsite Consequence Assessment System)	Wind field forecast; Atmosphere diffusion model; Dose evaluation and protection action partition	China Institute for Radiation Protection	Changjiang NPP, Tianwan NPP, Fuqing NPP



2. What have we done?

2.1 The atmosphere diffusion model

- Lagrange method, Eular method
- The Gaussian puff model
- The Lagrange stochastic particle model
- The LSPM-Air model developed at the CIAE makes use of variable time-step algorithm to enhance the computing efficiency. Variance reduction techniques are also applied for such a purpose.

2.2 LSPM-Ocean Model

After the Fukushima nuclear accident in 2011, studies and researches have been carried out on the ocean diffusion model. Based on the LSPM-Air model, a new model named LSPM-Ocean has been developed at the CIAE. Using the flow field data by the Princeton Ocean Model , this model is used to calculate the radionuclide concentration in coastal waters in nuclear accidents. The difference between LSPM-Air and LSPM-Ocean is mainly the boundary process technique. A method combined totally-reflecting algorithm and the self-avoiding algorithm is applied to deal with the collision problem of particle and coastline in the LSPM-Ocean.

Introduction to the LSPM-Ocean

The LSPM-Ocean, developed in the CIAE, is a Lagrangian Stochastic Particle Model and used to calculate the radionuclide concentration in coastal waters with the flow field data by the POM. It can give the concentrations of surface (about 1m thickness), middle and under water. This model includes some special technologies as follows:

- Variable time-step algorithm

This algorithm can automatically adjust time-step of integral according to the terrain grids and the time-step of the meteorological data. Thus it can decrease the number of times of the integral and enhance the computing efficiency.

A mixed method of the totally-reflecting algorithm and the self-avoiding algorithm is applied to deal with the collision problem of particle and boundaries (including coastline, sea surface and bottom).

- Variable bandwidth kernel estimator algorithm

This algorithm is used to build the concentration field. It uses the Epanechnikov function (a type of quadratic function) as the mass distribution function of the particle, where the bandwidth is the space scale for the range of influence of the particle with respect to the transport time of the particle. The method can reduce the concentration fluctuation with the absence of the more number of particle.

2.3 Decision-making support system development

- Cost-benefit analysis method
- Bayes method
- Multi-attribute effect method
- Fuzzy comprehensive evaluation method
- Un-structured fuzzy decision-making method.

3. What we need?

Based on the experience of developing and applying the system, it was found that there is still a long way to go.

- First, with reactor types and site characters, developing a nuclear Accident consequence assessment system, including accident source term prognosis, consequence assessment, decision-making support, nuclear information management, to evaluate middle and long distance, such as provincial or national scale, accident effect, needs a lot of work.
- Besides, system effectiveness and efficiency need to be considered, as well as the method to evaluate the model. Meanwhile, it is suggested that the IAEA provides a general benchmark, and performs data comparison between NARAC, JRODOS, and other assessment and prognosis systems, to format the system output.

E-Mail:li-pengbo@163.com