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**COMMISSION FOR BASIC SYSTEMS**
**OPAG on DPFS**

**Task Team on Development of Operational Procedures for non-Nuclear ERA**

Agenda item : 8

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# CAPACITY BUILDING FOR NON-NUCLEAR ATMOSPHERIC TRANSPORT EMERGENCY RESPONSE ACTIVITIES

*(**Submitted by RSMC-Beijing**)*

## Summary and purpose of document

This document summarizes the non-nuclear environmental response system which consist of regional mesoscale, large scale and urban small scale system. The non-nuclear exercises in recent years conducted by RSMC Beijing are introduced. The current problems and future plans are also illustrated…

## Action Proposed

The meeting is invited to update the status of the following actions proposed at the 2009 n-NRSMC expert team meeting

**Annex(es):** - …….
- …….

**Reference(s):** - …….
- …….

# 1. Introduction of non-nuclear services of RSMC Beijing

The non-nuclear services of Regional Specialized Meteorological Center (RSMC) Beijing include two main parts: emergency response services to hazardous chemicals leakage and emergency response services to volcanic eruptions and forest fires. The emergency response services to hazardous chemicals leakage mostly depend on the regional mesoscale and urban small scale environmental response systems. The latter part, in most cases, is based on synoptic scale system. Lately, Early Warning Project, called Meteorological Emergency Response Service System on Nuclear and Hazardous Chemical leakage, has integrated synoptic scale, mesoscale and small scale environmental response systems into one platform. The followings are the details of the three service systems on different scales.

## 1.1 Regional mesoscale environmental response system

In 2006, National Meteorological Center (NMC) began cooperation with Jiangsu Meteorological Observatory to develop the regional mesoscale environmental emergency response techniques and the corresponding system. In 2007, the system based on the mesoscale meteorological model WRF and dispersion model HYSPLIT4 was established. The new system went into operation in 2007 in Summer Olympic meteorological environment emergency response drills and played a role as an environmental emergency response system for 2008 Beijing Olympics.

Weather Research Forecast (WRF) model, developed by NCAR (the National Center for Atmospheric Research, USA), was used to provide the meteorological data in the regional fine-grid emergency response system. The region covered the entire China, with a resolution of 5 to 15 kilometers. The NETCDF library was applied as the interface processor to convert the model output into the required format for the input of dispersion model.

The latest version of HYSPLIT 4.9, developed by NOAA Air Resources Laboratory, was applied as the dispersion model in the mesoscale emergency response system. Lagrangian integration method applied in HYSPLIT model have a fast calculation speed for single point sources and therefore is ideal for the urgent situations such as emergency response. In addition, HYSPLIT model has good flexibility in parameter setting. Various parameter settings can support many different simulations, such as puff splitting, particle random walks, and Gaussian or top-hat

horizontal distribution.

To fulfill the demand of decision-making services, Geographic Information System (GIS) were applied to plot the output of dispersion model and a charting platform based on GIS was developed. The platform used maps with detailed geographic information as background. It could provide the following standard products: 3D trajectories of the pollution in 24 hours after the release, 3-hour interval averaged concentration of the pollution in 12 hours after the release, accumulated deposition in 12 hours after the release.

**1.2 Large-scale environmental emergency response system**

Until 2011, the meteorological field of large-scale environmental emergency response system has been T213L31 model, one global numeric forecasting model of NMC. The version of the dispersion model HYSPLIT was 4.8. In 2011, the emergency response system was updated. T639L31 instead of T213L31 and HYSPLIT 4.9 instead of 4.8 were put into operation. The updates enhanced greatly to the response abilities of RSMC Beijing.

T639 model provides a higher-resolution meteorological background than T213. T213 model has 31 vertical layers and the top layer reaches 10 hpa, while T639 model has 60 vertical layers and can reach 0.1 hpa. Compared with T213 model, the resolution of vertical boundary layer in T639 model is higher. Below the 850 hpa level, there are 5 layers in T213 and 12 layers in T639. Therefore, T639 is able to give a more detailed description on boundary layer and the new products could be more informative for decision-making. Besides, 3DVAR data assimilation was applied in T639, which enables assimilate observation data from the microwave soundings on the polar-orbiting satellites.

In addition, the dispersion model in operation was updated from HYSPLIT 4.8 to a more functional HYSPLIT 4.9. The paralleled computing could be implied and the calculation efficiency might be promoted significantly.

**1.3 Urban small scale environmental response system**

Urban small scale environmental response system is a fresh developing system for RSMC Beijing in recent years. The main body of the system is the microscale model developed by Beijing Meteorological Bureau. The model considered the constructions and different types of surface. It was mainly used to simulate the dispersion problem happened in city districts at the scale from 1 to 2 kilometers. When combined with urban geographic information, the model can

give a meticulous description on the influence caused by the constructions, streets and different plants at surface.

The dispersion model has quite good performance on different situations. With assimilated observation data, the model can simulate the meteorological and pollution dispersion characteristics in the city. A description on the dispersion paths of gas pollutants can be given, and the influence on the temperature and temperature changes by the building could be reflected reasonably. The dispersion model has been in operation of Beijing Climate Center and performed well in many exercises, especially in many drills for 2008 Beijing Olympics.

# 2. RSMC Beijing non-nuclear exercises in recent three years

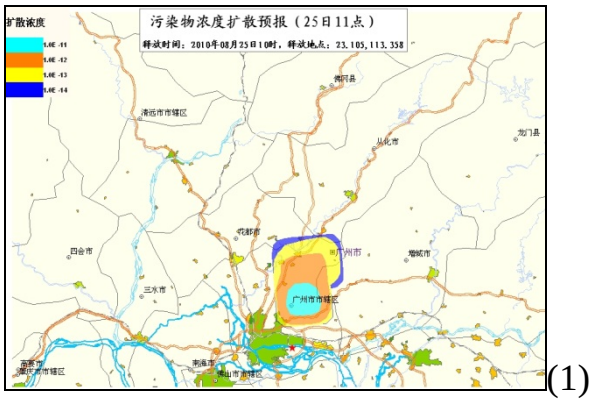
In recent three years, RSMC Beijing completed many non-nuclear exercises. Special reports on the emergency response drills for major events in China were provided, and background information on volcanic eruptions was submitted. The following is the summary of non-nuclear exercise tasks of RSMC Beijing in 2010 and 2011.

## 2.1 Non-nuclear exercises in 2010

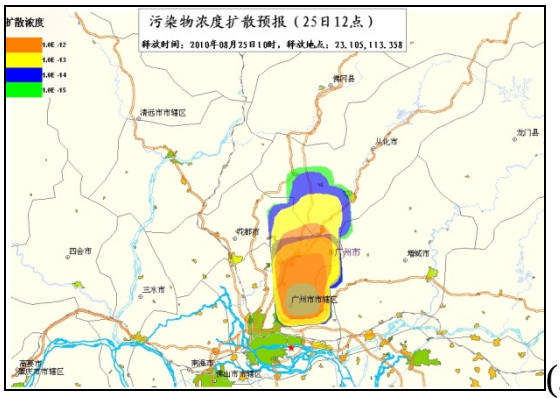
### 2.1.1 Guangzhou Asian Games

RSMC Beijing provided meteorological services on pollutant dispersion matters for Guangzhou Asian Games. The following products were provided, including trajectories, averaged concentration from 0 to 100 m, and accumulated deposition.


Fig. 5 6 hours forecast of trajectories at 10, 500 and 1000 m.




(1)

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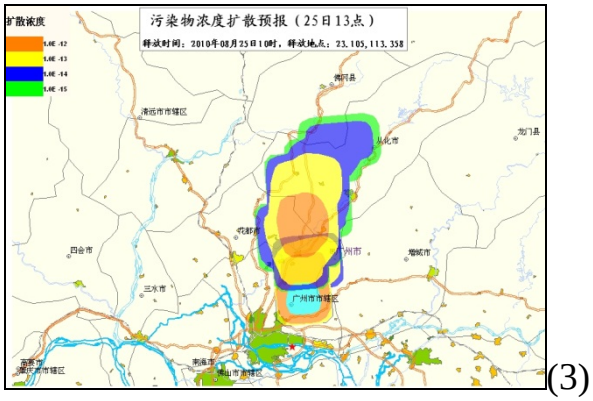


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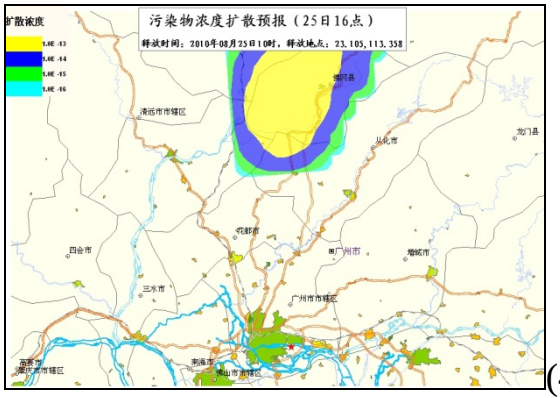


(4)

Fig.6 average concentration at the layer 0～100m（1,2,3,4 corresponding to 1,2,3,6 hours interval）

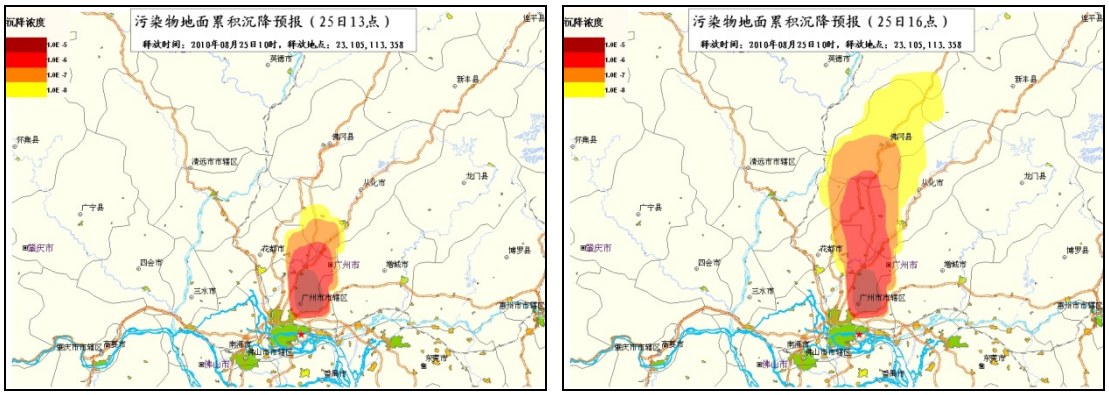


Fig.7 accumulated deposition (left/right corresponding to 3/6 hours interval)

### 2.1.2 Shanghai World Expo

In 2010, RSMC Beijing took a part in the meteorological response service led by NMC. The provided products consisted of 12-hour forecast trajectories, 6-hour forecast averaged concentration, and 6-hour forecast accumulated deposition.


Fig. 8 12-hour forecast 3D trajectories (red,10m; blue, 500m, green, 1000m)

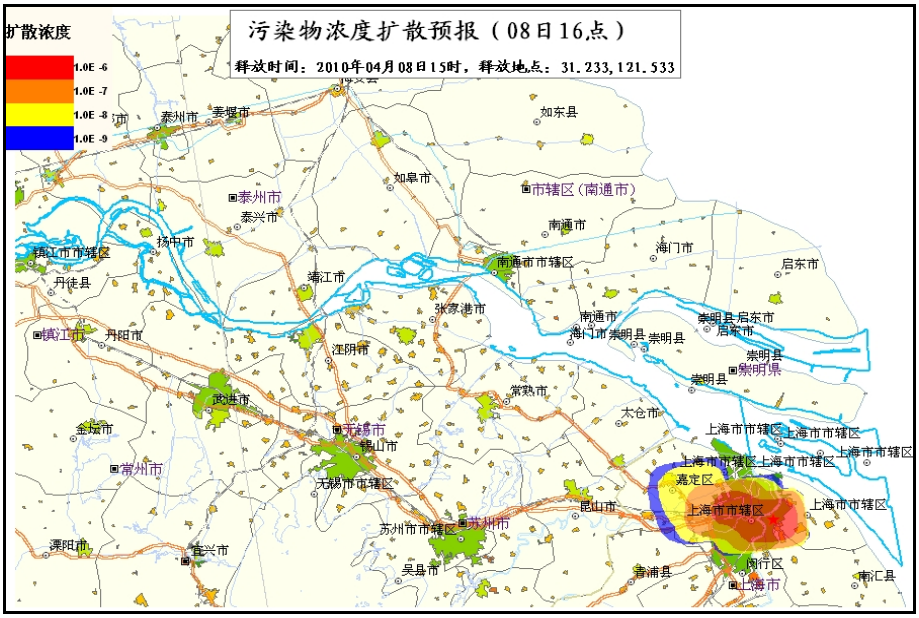


Fig.9 1 hour forecast averaged concentration at layer (0-100m)

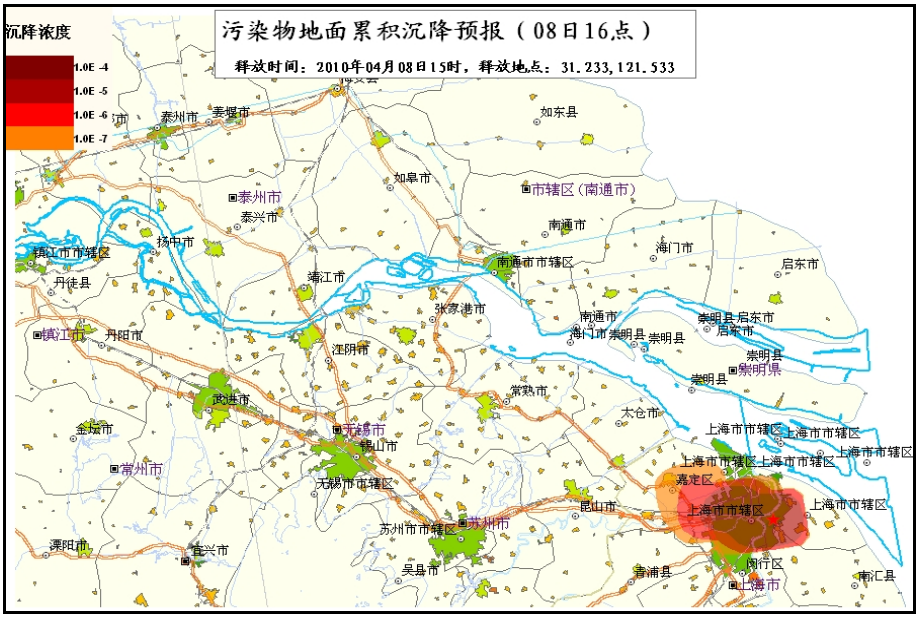


Fig. 10 one hour forecast accumulated deposition

## 2.2 Non-nuclear exercises in 2011

### 2.2.1 Iceland Volcanic Eruption

RSMC Beijing produced background information on Iceland volcanic eruptions. The provided products contained the trajectory simulations for one week after the eruption, and the averaged concentration of volcanic ashes from 1725 m to 8000 m.

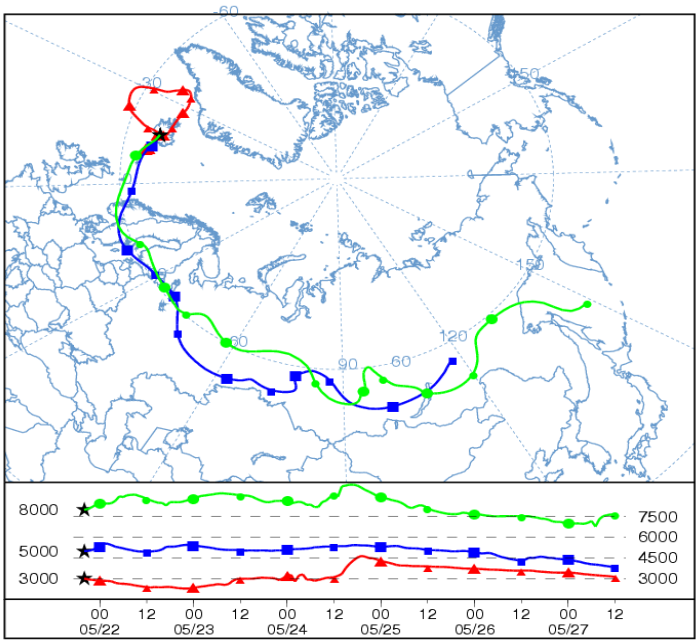


Fig. 11 Trajectory forecast of ashes starting at different heights
(red, 3000m; blue, 5000m; green, 8000m)

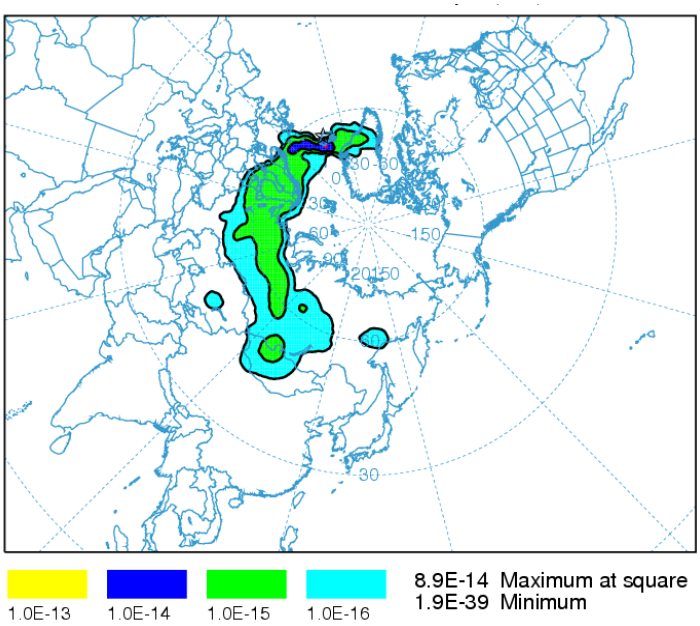


Fig. 12 averaged concentration of the layer (1725-8000 m) at 12:00 UTC on May 26th

### 2.2.2 Chile Volcanic Eruption

RSMC Beijing provided background information on Chile volcanic eruptions. The products included the trajectory simulations for six days after the eruption, and the averaged concentration of volcanic ashes from 1725 m to 8000 m

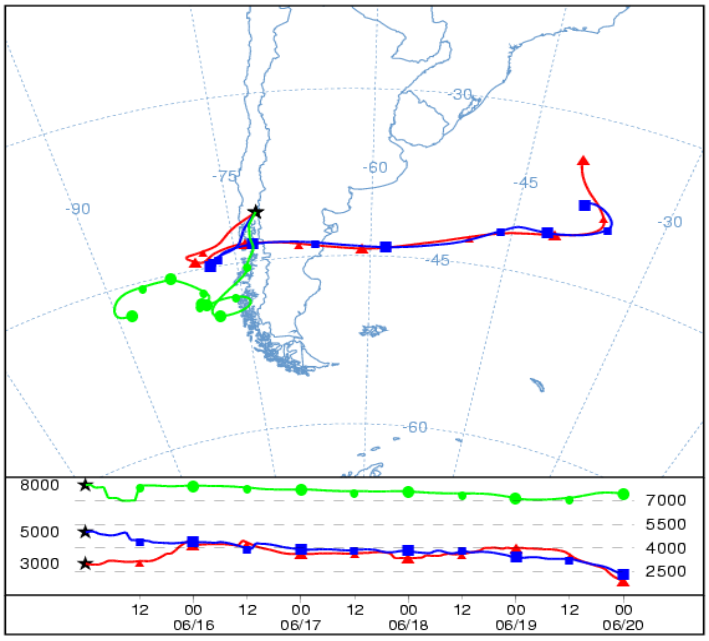


Fig. 13 Trajectory forecast of ashes starting at different heights
(red, 3000m; blue, 5000m; green, 8000m)

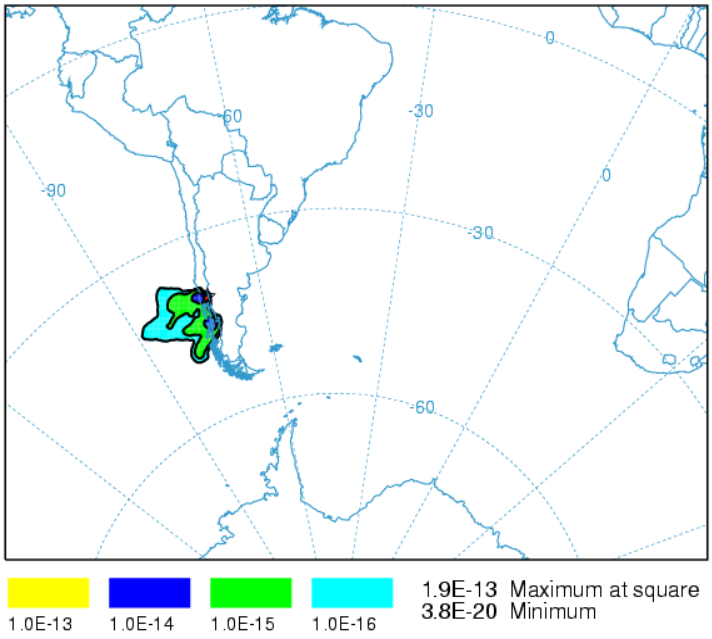


Fig. 14 averaged concentration of the layer (1725-8000 m) at 00:00 UTC on June 16th

### 2.2.3 Shenzhen Universiade

RSMC Beijing did some preparation for Shenzhen Universiade. The product includes concentration.

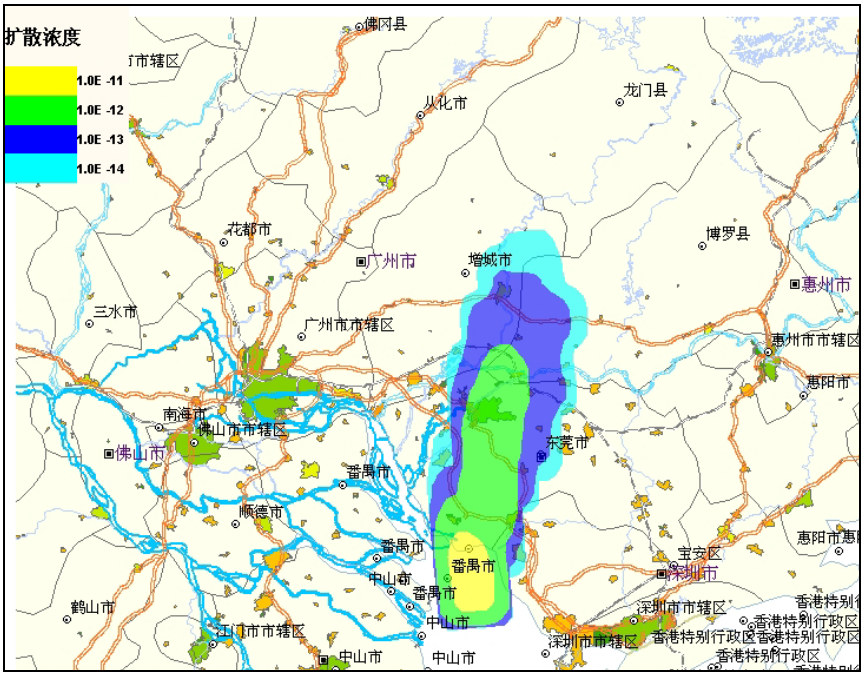


Fig. 15 Averaged concentration of the layer (0-100 m) three hour after release

# 3 Emergency response system in Earth Warning Project

Meteorological emergency response service system for nuclear and hazardous chemicals leakage is the support platform of RSMC Beijing. The platform integrates large-scale, regional fine-grid and small-scale meteorological emergency response systems.

Large-scale meteorological services are based on T213, T639, GRAPES-Global, and NCEP-GFS, with HYSPLIT as dispersion model. The products are sent to IAEA, CTBTO, and other users in China. Large-scale non-nuclear services are designed to the situations such as toxic chemicals leakage, forest fires, volcanic eruptions and others. The calculations can be forward and backward. Forward forecast products include trajectories, concentrations and depositions; backward calculation products include concentrations.

Regional fine-grid emergency response system imports mesoscale meteorological data such as WRF, MM5, GRAPES-Meso. HYSPLIT model is used to calculate the dispersion products. Non-nuclear services include toxic chemicals leakage, forest fires, volcanic eruptions and others. The provided products consist of trajectories, concentrations and depositions.

Microscale emergency response system applies observation data, including observation data from automatic weather station and surface data. Non-nuclear services are designed to toxic

chemicals leakage and others. Products are concentrations, danger zone recognition, cordon and decision-making products.

In addition, Meteorological emergency response service system for nuclear and hazardous chemicals leakage supports many methods to initialize requests and send products. Requests can be initialized by email, fax, SMS and website. Products can be sent by email, fax and ftp.

# 4 Current system problems

The emergency response systems in RSMC Beijing have the following problems.

Mid-scale and large-scale emergency response systems applies one-way coupling for meteorological forecast and dispersion model. The coarse resolution of wind fields will have a negative effect on the simulation results. At present, the WRF model in operation outputs one hour each time, but the initial field assimilates twice a day. As for the mesoscale simulation in a region of 100 km, one hour time resolution is rather coarse and pose negatively on the products. The same problems happen in the large-scale emergency response system.

The emergency response system needs some improvement on the setting of chemical and physical properties of toxic chemicals.The system for showing the products need to be more friendly for the users. The system can support the output such as trajectories, concentrations and deposition, but do not support 3-dimensional illusion for the products.

Current barrier of calculation efficiency lies on the transforming meteorological data. For example, HYSLIT required meteorological data in the form of arl. However, T639 output the meteorological fields in the form of grib2 and WRF in the form of NETCDF. As a result, much calculation and storage space are spent on the transformation。

# 5 Future plans

To solve the problems mentioned above，RSMC Beijing plans to improve the system in the following ways.

A new environmental emergency response system based on GRAPES-RUC has been established. GRAPES_RUC assimilates the initialization fields every 3 hours and can provide a more ‘real’ meteorological fields to HYSPLIT.

A new project, named ‘atmospheric dispersion forecasting and risk assessment systems for hazardous gas leakage’, will be applied. The results from research on the chemical and toxic of

chemicals will be integrated into the current system. In the future, poison dose and chemical properties will be considered in the simulation to enhance the quality of the decision-making production.

3-D visualization technology based on GIS will be developed to establish a GIS decision-making support system. The system will support the meteorological field simulation, dispersion simulation and decision-making support. A high resolution GIS information database will be established.

The interfaces between WRF, T639 and HYSPLIT will be improved to increase the efficiency. A new module is going to be developed to make HYSPLIT support the NETCDF and GRIB format.