International Civil Aviation Organization

INFORMATION PAPER

Asia and Pacific (APAC)
Eleventh Meeting of the Meteorological Requirements Working Group (MET/R WG/11)

Online, 31 May to 03 June 2022

Agenda Item 6: Any other business

NORTH CHINA METEOROLOGICAL CENTER RAPID REFRESH PREDICT SYSTEM

(Presented by China)

SUMMARY

Convective weather especially thunderstorm is the most important weather that affect flight in north China. In order to provide ATM controller and stakeholders with more effective MET information to optimize the regional flights operation, **the North China Meteorological Centre Rapid Refresh Predict System** has been developed. This paper presents the development of the system, the technical route and the output products.

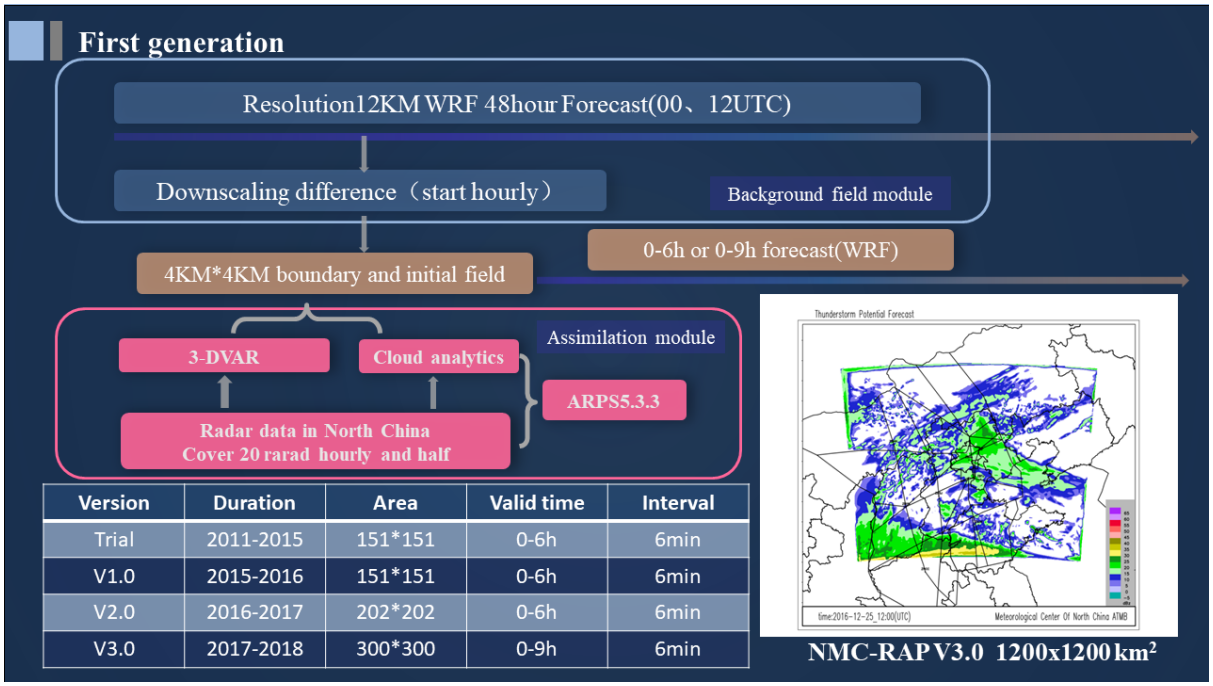
1. INTRODUCTION

1.1 **The North China Meteorological Centre Rapid Refresh Predict System** (Hereinafter referred to as **NMC-RAP**) has been running for 7 years. During these times, the system has been provided high-quality meteorological services to ATM controller of north China, who could use MET information to make ATM decisions. Although the system was officially launched in 2015, the development of the system began in 2010.

1.2 The most important reason of designing **NMC-RAP** was that airspace flow increased rapidly, and the need of flow management for special MET information. From 2015 to 2018, it is the first generation of NMC-RAP, the system had gone through three version development: 1) The forecast range was expanded from 600 by 600 km to 1200 by 1200 km; 2) The forecast period was extended from six to nine hours.

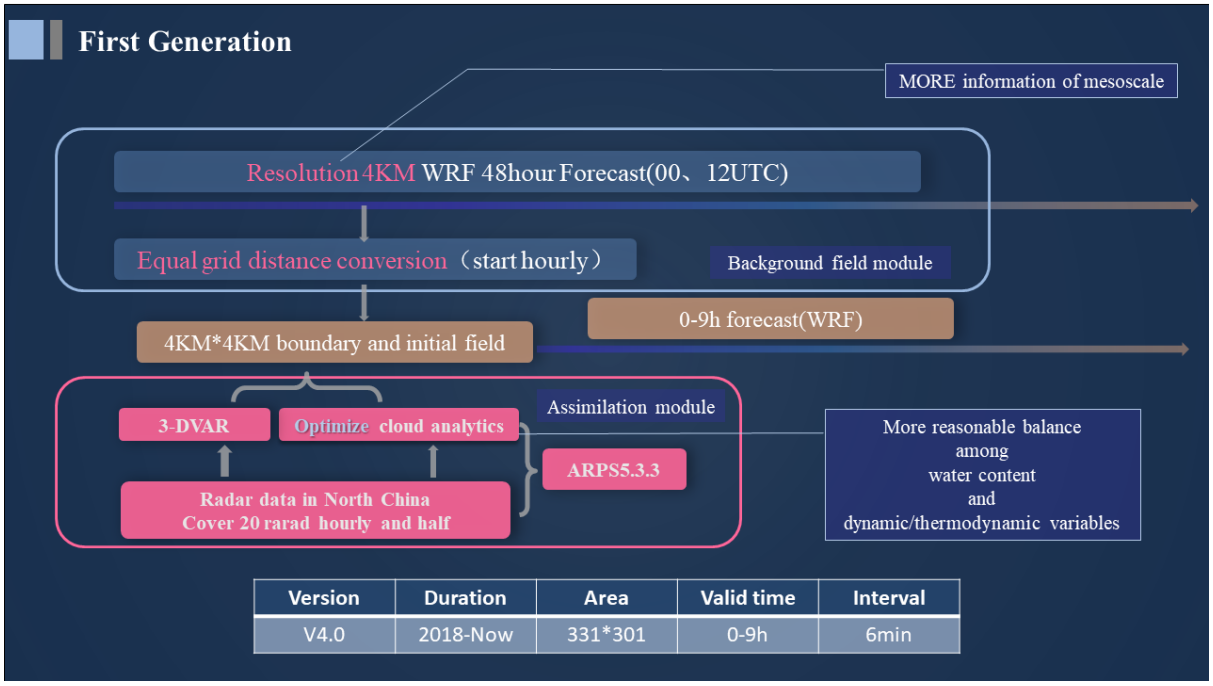
The first-generation of system (**Fig. 1)** based on the Weather Research and Forecasting and Advanced Regional Prediction System models. The established aviation weather system can assimilate the hourly radar data in North China and provide the 0-9h forecasts of severe convection. Horizontal resolution was 12km. Complex cloud analysis technique is applied in the assimilation with radar reflectivity data to modify the hydrometeors and the temperature in the clouds, which benefits the prediction of the occurrence, development and evolution of severe convection and shortens the spin – up time of the forecasting system.

In 2018, the technology of the first-generation system was upgraded for the fourth version (**Fig. 2)**. Horizontal resolution was been increased to 4km, and the optimized cloud analysis gains more reasonable balance among water content and dynamic/thermodynamic variables in the model.



Version	Duration	Area	Valid time	Interval
Trial	2011-2015	151*151	0-6h	6min
V1.0	2015-2016	151*151	0-6h	6min
V2.0	2016-2017	202*202	0-6h	6min
V3.0	2017-2018	300*300	0-9h	6min

Fig. 1. Technical Route of First Generation from V1.0 to V3.0



Version	Duration	Area	Valid time	Interval
V4.0	2018-Now	331*301	0-9h	6min

Fig. 2. Technical Route of First Generation V4.0

1.3 The second generation system is designed to solve problems which is existing in the first generation system, such as the vapour imbalance in the model caused by reflectivity data converting into water content. The method to solve the problem was applying the latest rapid cycling assimilation concept in the system.

$$LH(i,j,k) = \left(\frac{1000}{p}\right)^{R_d/c_p} \frac{(L_v+L_f)(f[Z_e])}{t^* c_p} \qquad (1)$$

In simple terms, it is that the radar reflectivity is converted into temperature tendency term, and add it into the equations before the lead time of prediction. Equation (1) shows how to evaluate the Latent Heating Rates (temperature tendency). The equation include f[Z_e] which means Reflectivity factor converted to rain/snow condensate.

The Latent Heating Rates come from radar reflectivity was interpolated into prediction equations by 2 times before lead time, interpolating intervals is 30 minutes.

The above method comes from American High-Resolution Rapid Refresh (HRRR) technology, so we call this technical route HB-HRRR (**Fig.3.**).

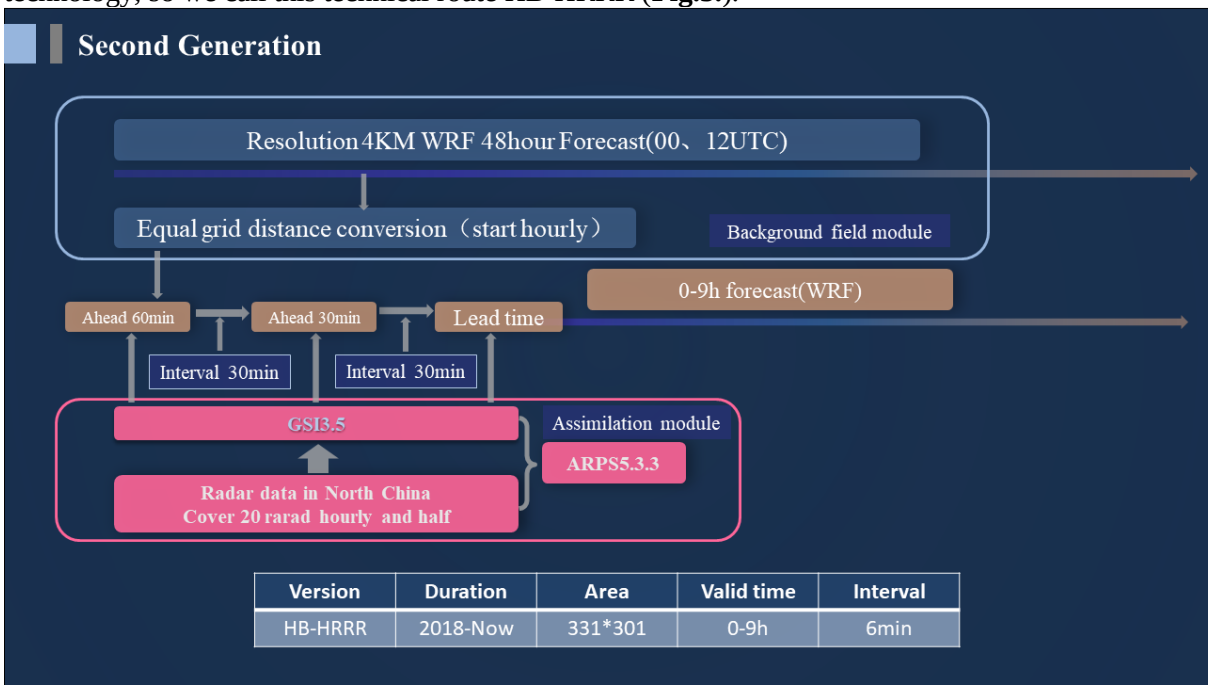


Fig. 3. Technical Route of Second Generation HB-HRRR

1.4 It is 20 radar's reflectivity data which from the north China was assimilated into the both first and second generation. So far, the two generations have provided service at same time.

1.5 When the system was launched, it was the first mesoscale convective prediction system of CAAC with independent intellectual property rights, and it outputs only one product, the radar reflectivity factor, primarily to meet the needs of the traffic flow management.

1.6 The NMC-RAP has ran stably 7 years, it has been more accurate prediction of warm area thunderstorms and pre-system induced thunderstorms than another numerical model just like EC & GRAPS-MESO and so on. Therefore, the system not only supports decision-making for fine flow management, but also provides reference information for forecaster and increases forecaster's confidence.

2. DISCUSSION

The need of CDM

2.1 Before COVID-19, air traffic flow in North China had been increasing year by year. Significant convective weather associated with thunderstorms are one of key factors that could affect the Collaborative Decision Making (CDM).

Under the background of large flow operation, the combination of meteorological information and air traffic flow management becomes the basis for ensuring safety and improving efficiency in convective weather scenarios. The only product available is the numerical simulation of radar reflectivity because radar reflectivity is one of the meteorological information most familiar to air traffic flow controllers.

2.2 At present, in order to calculate the ratio of capacity to flow in different regions, air traffic flow management requires that the ratio of coverage of convective weather be provided in the sub-region, and a new generation of convective forecast system is in trial operation.

Future convergence of meteorology and ATM

2.3 Although the current system provides objective product, manual intervention is deeded that it transforms MET information into decision-making of air traffic flow management.

2.4 Future convergence of meteorology and ATM is the objective product of MET which could be adopted into air traffic flow management system without human intervention.

3. ACTION BY THE MEETING

3.1 Note the information contained in this paper.

– – – – – – – – – – – – – –