WORLD METEOROLOGICAL ORGANIZATION

CBS/OPAG-IOS/WxR_EXCHANGE/3.1.2

COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP
ON INTEGRATED OBSERVING SYSTEMS

16.IV.2013

WORKSHOP ON RADAR DATA EXCHANGE

ITEM: 3.1

EXETER, UK, 24-26 APRIL 2013

Original: ENGLISH

CURRENT STATUS OF WEATHER RADAR DATA EXCHANGE

Regional Report on the current status of the exchange of weather radar data – RA II

(*Submitted by Li Bai, China)*

SUMMARY AND PURPOSE OF DOCUMENT

To inform the Workshop on the current status of Weather Radar data exchange in Region II.

ACTION PROPOSED

The Workshop is invited to note the information presented in the document.

APPENDICES

Appendix: WRDE Report: Status of Radar Data Exchange in Region II

WORKSHOP ON RADAR DATA EXCHANGE –INTRODUCTION TO THE EXCHANGE OF RADAR DATA IN RAII (EXETER,UK, 24-26 APRIL 2013)

1. Introduction

This document mainly introduces an outlook on data exchange in China, including the deployment, data transmission and application, some suggestions are proposed in the end.

2. Development of CINRAD

We have planned to build 216 New Generation Doppler Weather Radars around China, which is called CINRAD (China New Generation Weather Radar). The first CINRAD was built in Hefei, Anhui Province, in 1999. By the end of 2012, 178 radars have been built, of which 144s have been put into operation and the rest 34s are in the progress of deployment. Fig. 1 shows the scene pictures of some CINRAD's towers in China and Fig. 2 demonstrates the distribution of the 216 CINRADs over China. We can see from Fig. 2 that S band (2700MHz-2900MHz) weather radars are mainly distributed in east and coastal areas in southern China while C band (5300MHz - 5500MHz) are mainly located in the northern and western parts of China. According to the maximum unambiguous range and velocity range of CINRAD as well as the impacts of atmospheric attenuation and the earth curvature, the distance between two neighboring radar site should be 200-250km apart, but the distance should be shortened to 100-150km apart in some special areas, such as the frequent disaster impacted areas, key service areas, economically developed areas, mountainous and hilly areas and places with amount of precipitation over 800 mm per year. In addition, in order to improve the security of radar network in case of severe weather, the distance can be shortened to 100km apart in some special areas. Fig. 3 shows the coverage of CINRAD at 1500 m and 3000 m height above sea-level. It can be seen that the network of CINRAD covers most of the China's territory in the mainland. Fig. 4 shows the coverage of radar network at different altitudes in the East China and Central China regions. Lots of observation data indicate that CINRAD is capable to improve the accuracy of nowcasting of severe weathers, playing important roles in forecasting and warning the disastrous weather events like typhoon, rainstorm, hails, etc.

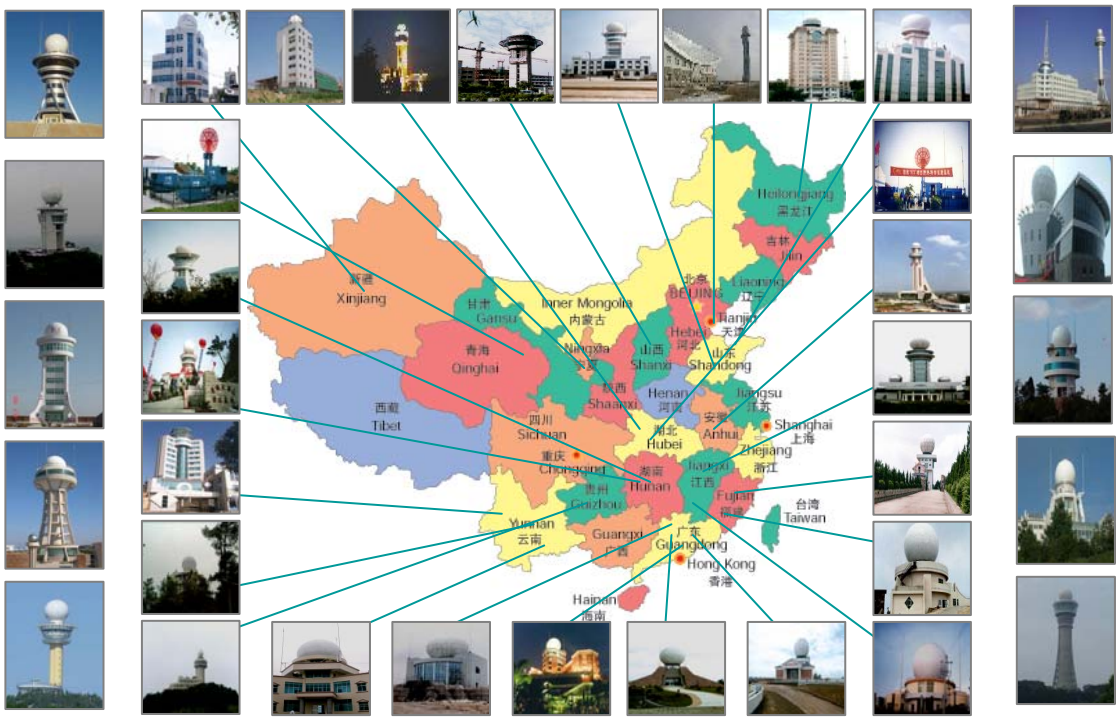


Fig. 1 Some scene pictures of CINRAD Tower in China

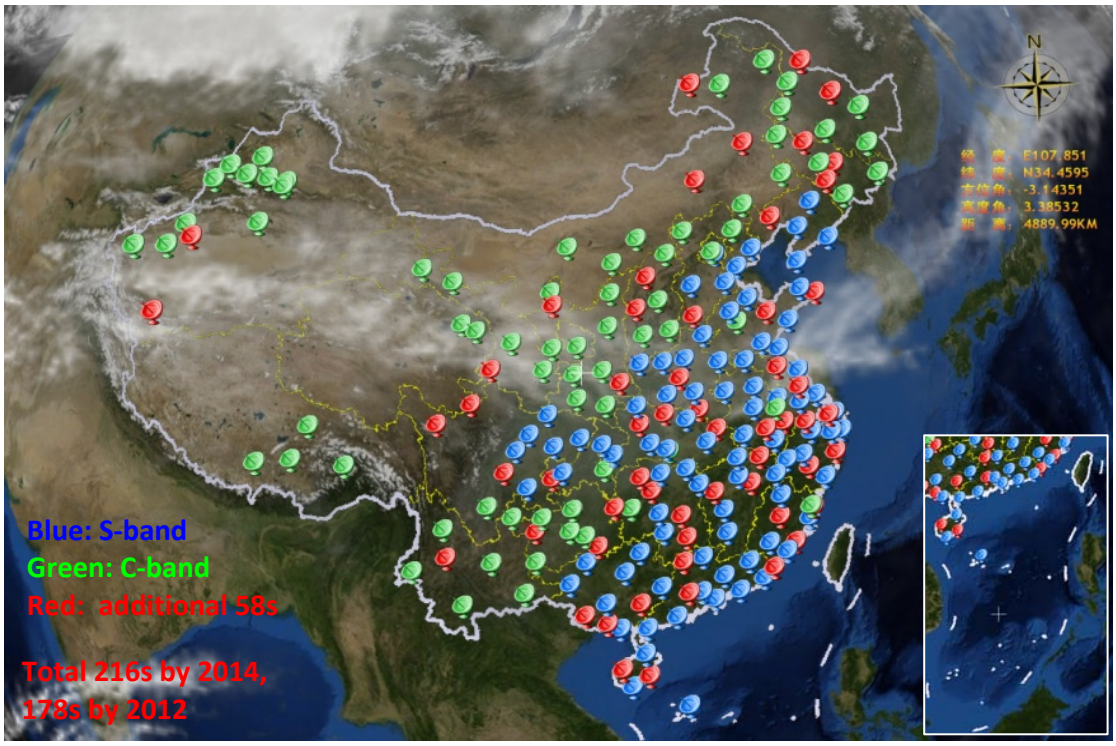


Fig. 2 Deployment of 216 CINRADs over China

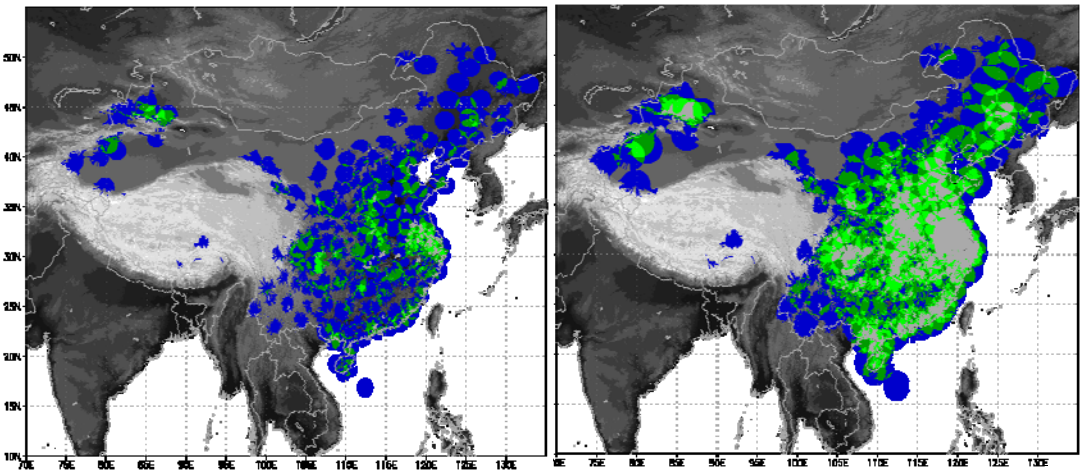
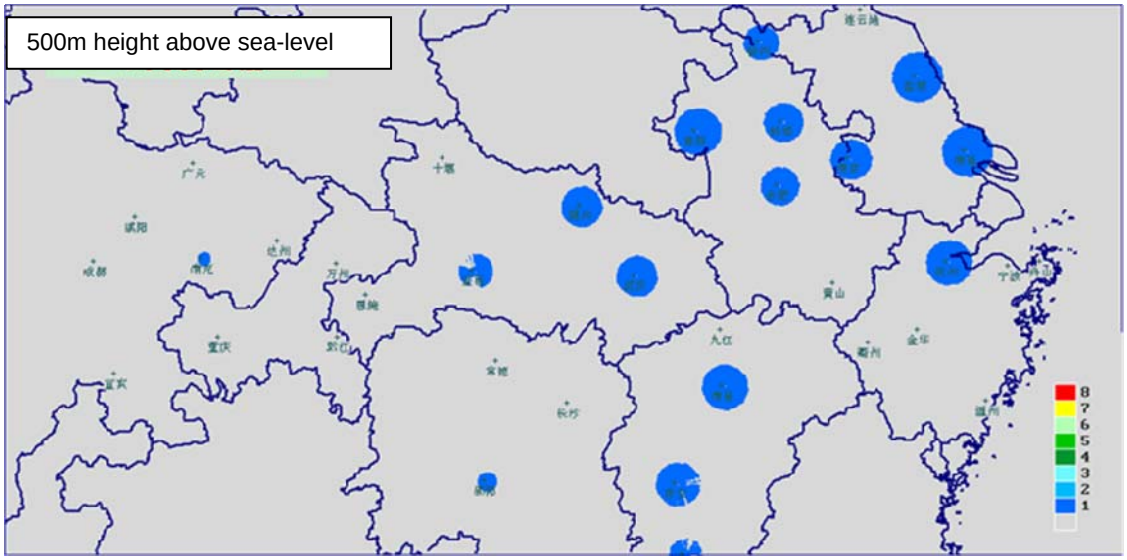
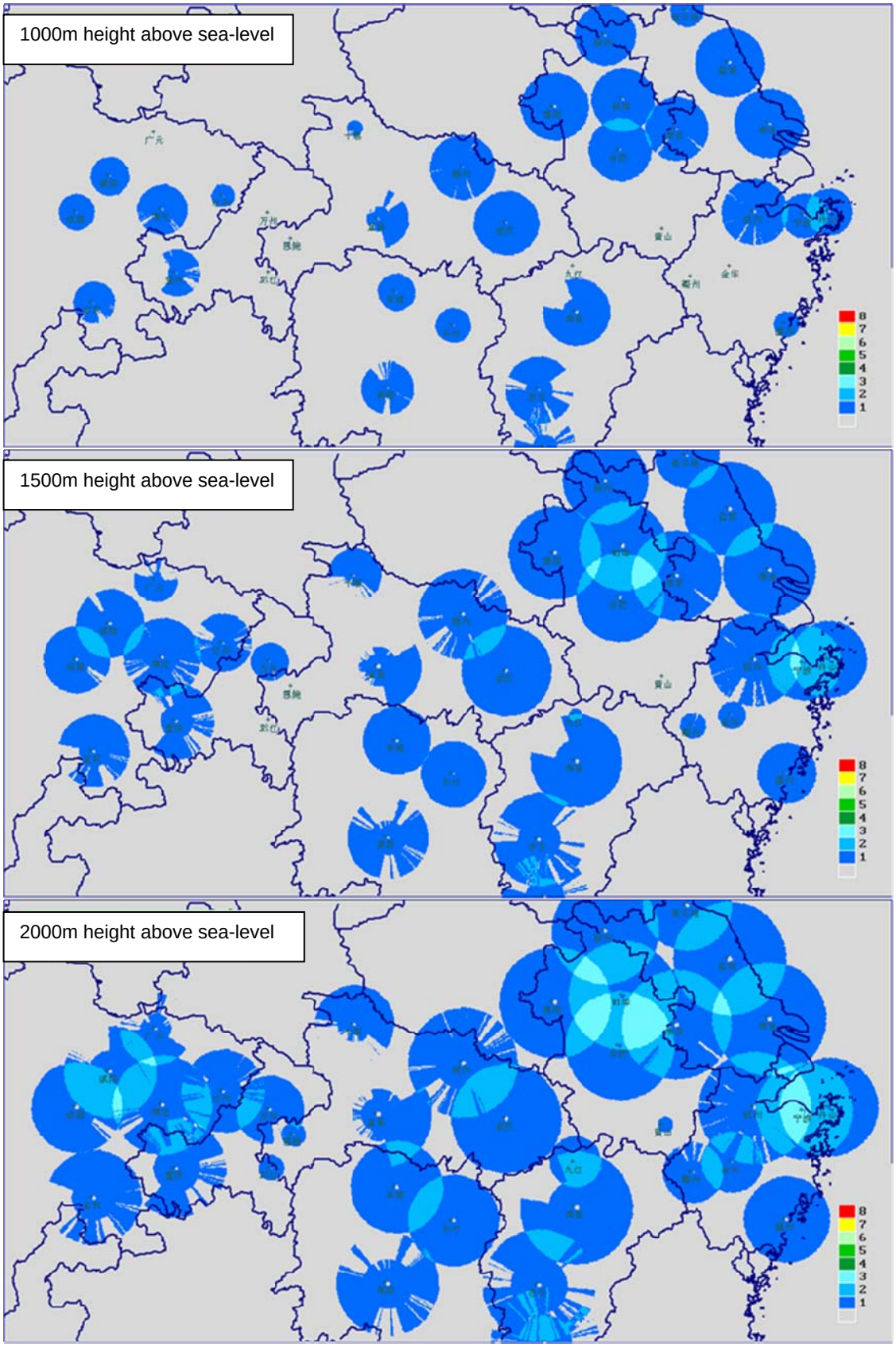


Fig. 3 The radar coverage over China Mainland at 1500 m and 3000 m height




1000m height above sea-level
1500m height above sea-level
2000m height above sea-level
8
7
6
5
4
3
2
1

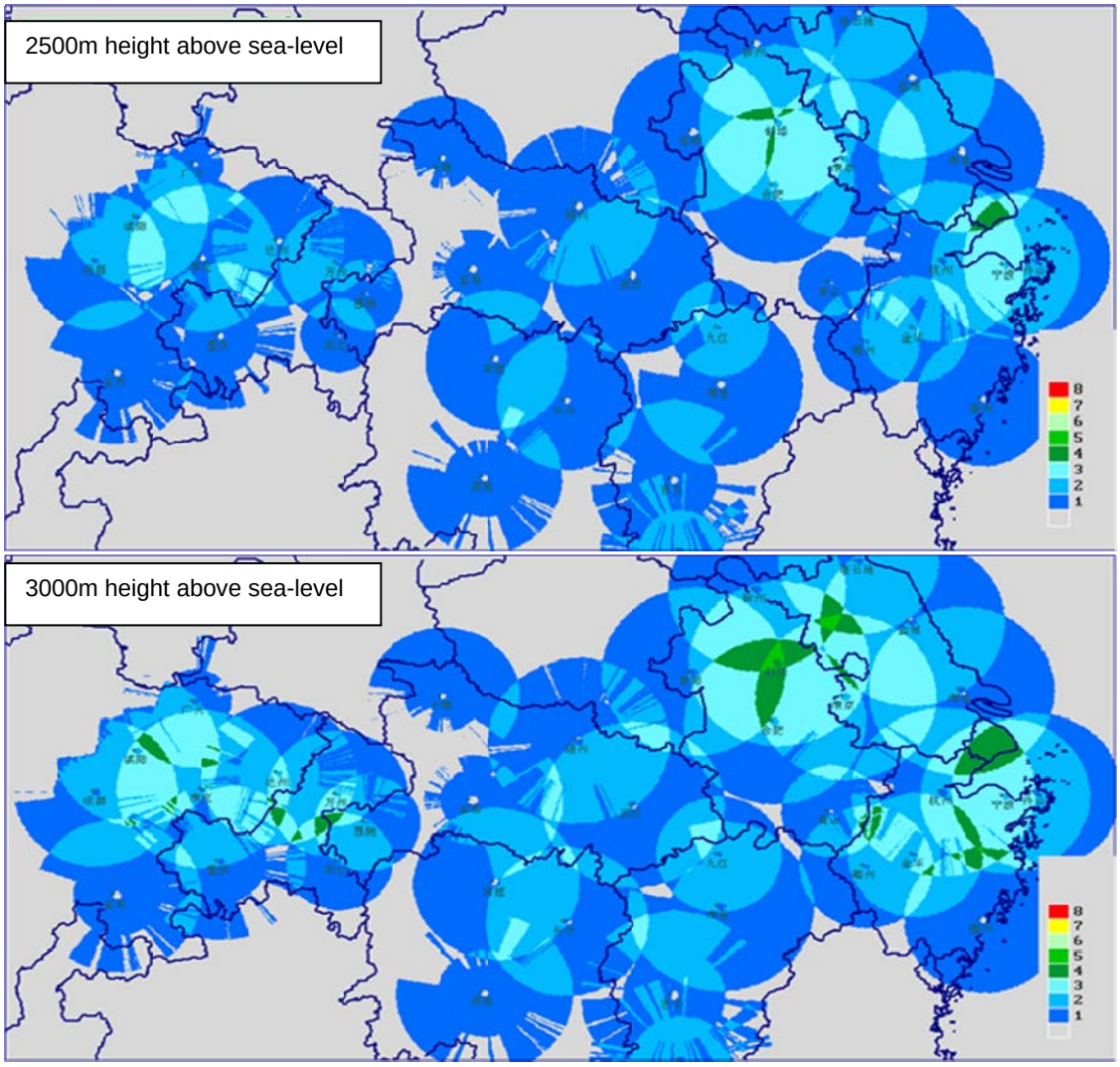


Fig. 4 Coverage of regional radar networks at different height in East China and Central China

3. Current operation status and utilization of data

Generally speaking, the operational performance of CINRAD in China looks good. Based on the evaluation of the CINRAD operation in the past years, the operational availability of CINRAD has increased stably year by year from 89.49% in 2006 to 98.18% in 2011. The MTBF decreased gradually from 29.85h to 13.45h during 2008-2011.

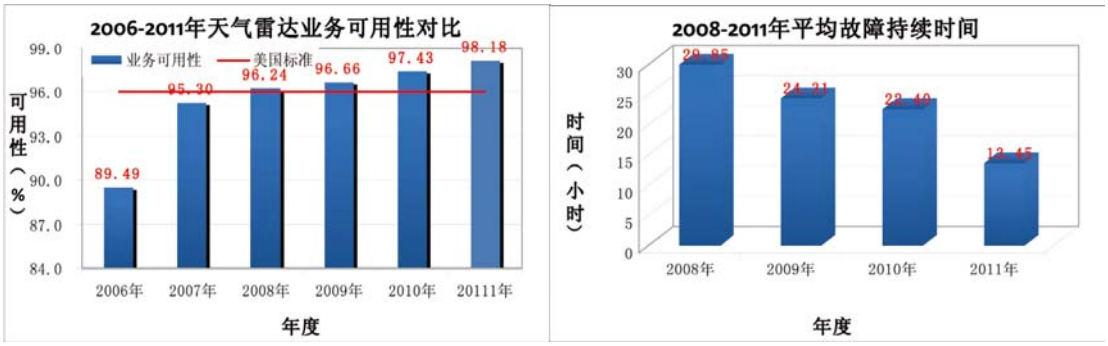


Fig. 5 Evaluation on the operation of CINRAD(Left figure:CINRAD Operational Availability during 2006-2011, Green color represents Operational Availability, Red color represents American standard. Right figure: Mean Failure Duration during 2008-2011)

4. Data transmission

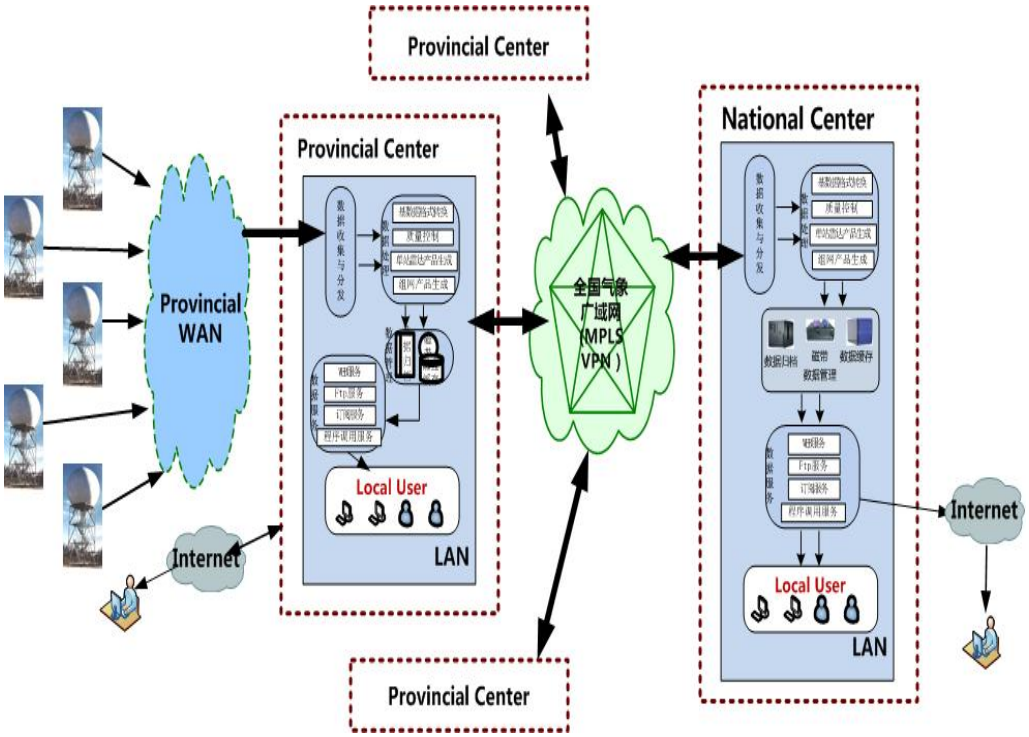


Fig. 6 Flow chart of radar data transmission

At present, the radar data in China are stored in three levels, i.e., national level, provincial level and radar site level. After collected by radar site, the data are transmitted to provincial centers through the wide area network (WAN) within the province, and then after being stored by the provincial center, the data are transmitted by the national meteorological WAN to the national center for storage. Radar data are divided into base data product, single product, mosaic product, the case data and the State & Warning Information. The storage periods of radar data in the three-level centers are shown in Table 1.

Table 1 Storage periods of radar data at radar site, provincial and national centers

	Base Data	Single-site Product	Network Product	Radar Case Data	Radar State and Warning Information
National Center	> 3 years online	> 3 years online	> 1 year online	> 20 years online	> 3 years online
	Permanently stored offline	/	/	Permanently stored offline	Permanently stored offline
Provincial Center	> 3 years online	> 3 years online	> 1 year online	> 20 years online	> 3 years online
	Permanently stored offline	/	/	Permanently stored offline	Permanently stored offline
Radar site	> 14 days	> 14 days	/	/	> 14 days

By the end of December 2012, 144 radar sites over China have been put into operation, transmitting radar data every day. The data transmitted from radar sites to the National Meteorological Information Center includes 10 kinds of radar PUP products and the transmission interval is less than 15 minutes. The provincial centers share radar base data and the interval for data transmission is less than 14 minutes. It takes less than 5 minutes to transmit the data to users after receiving the data from the National Meteorological Information Center. The data format includes basic data format and product data format, using binary encoding. The current base data format is the same as WSR-88D format.

Radar data operations include: data collection and distribution, format conversion of radar base data, quality control of radar base data, single-site and network product processing, single-site and network image product generation, data management, data sharing service and operational monitoring, etc.. Table 2 shows the specification of functions and time-effective.

Table 2 Brief introduction to the function and target of radar data operation

Operational Function	Function Introduction	Time-Effective Target
Data collection and distribution	Efficiently collect the data delivered by radar sites or other centers, and meanwhile define the data according to configuration and then send to other centers or other systems inside this center.	Finish within 1 min
Format conversion of radar base data	Convert the 7 kinds of radar base data that are submitted by the radar sites around the country into standard format. The 7 radar base data formats include the different base data formats of the SA, SB, SC, CB, CC, CD and CCJ radars.	No
Quality control of radar base data	Use various quality control method to clear the ground clutter of single-site radar base data, process the average radial velocity aliasing, abnormal echoes and intermittent point clutters, and correct the attenuation of radar rainfall areas.	Finish within 2 min
Radar single-site product processing	Use the quality-controlled base data or other single-site data products to create basic products such as the reflectivity ,the radial velocity and spectrum width or the single-site products like composite reflectivity and echo tops, etc.	Finish within 4 min
Radar network product processing	Put the grid-pointed single-site base radar into network, generate the nationwide or regional network base reflectivity, network composite reflectivity, network vertical accumulated liquid water content, network vertical liquid water density products.	Finish within 10 min
Radar single-site and network image product processing	Make radar single-site and network products graphical and produce all kinds of unprocessed resolution pictures and fast-scanned pictures of the products.	Finish within 10 min
Data management	Store and manage radar data and all types of products normally, including the data storage and management, backup and recovery, data migration and movement, data clearing, metadata management and update, data archiving.	
data sharing service	Push real-time radar data and products to users quickly, supply the fast-scanning function of the normal products based on single radar, provide the catalogue service (metadata retrieval) of radar data and products for users, and offer the query, download and customization of the whole network radar data and product as well as the user management function, etc.	Online retrieval/download:<2min; Near line data customization:<30min; Offline data customization:<24h.
Operational monitoring	Monitoring the system running status and the data collection, processing, storage, distribution and application; supply reminding, warning and automatic making-up functions to ensure the system's safe and stable running.	Real-time monitoring

5. Application of CINRAD in weather forecast service

5.1 In nowcasting operation

In China the radar quantitative precipitation estimation has been gradually applied in weather forecast operations. Radar can supply regional precipitation data in time, provide spatial distribution of large-scale rain clouds and intensity variation of precipitation, and offer the movement information of precipitation particles. Radar products play important roles in the monitoring and warning of typhoon, thunderstorm, strong winds, hails, squall line, severe weather, heavy rainstorms and other disastrous weather. This is of great importance for the development in meteorology and hydrology.

In addition, CINRAD is also applied in RUC in nowcasting operation. For example, VDRAS, which is the variational radar data assimilation system developed by NCAR, is used to carry out the basic quality control and thermal dynamic characteristic reversion for the data of 4 S-Band radars (in Beijing, Tianjin, Shijiazhuang, and Qinhuangdao) and 2 C-Band radars (in Zhangbei and Chengde), establishing the nowcasting model which can be integrated with radar echo, atmospheric electric field instrument and lightning detection data. In addition , the meso-scale operational forecasting model system BJ-RUC is also running in real time, in which Doppler radar data contributes greatly to the precipitation forecast.

5.2 Application of CINRAD in GRAPES_RUC

In 2009, Doppler weather radar VAD assimilation operator was completed in GRAPES_RUC system, and quality control technique was constructed in terms of the data error source. In May of 2010, the GRAPES_RUC system was put into trial operation, the VAD data from 60 weather radars in the central and eastern parts of China were used in real time and playing important roles, In 2012 the experimental study on the application of 3-D cloud analysis, which is based on radar reflectivity 3-D mosaic and satellite data, in GRAPES_RUC was finished. The results show that the

3-D cloud analysis technique can effectively improve the accuracy of nowcasting. Currently, the operation of 3-D cloud analysis technique is gradually improved.

6. Exchange of internal and regional radar data

6.1 Data exchange over China mainland

China Integrated Meteorological Information Service System (CIMISS) has been established in China, so the radar data can be transimitted to many departments in time, such as Civil Aviation, water resources, army and scientific research organizations etc.

There are 4 weather radars in Taiwan island, 5 C-band Dual-polarization weather radars will be constructed in the future, so the data exchange will be considered between China mainland and Taiwan island, especially mosaic products.

6.2 Data exchange between Guangdong and Hong Kong

Guangdong Provincial Meteorological Bureau and Hong Kong Observatory exchange their base data of weather radar. The data exchange is exchanged by the MSTP special line between Guangzhou and Hong Kong according to the network requirement of WMO Information System (WIS) to the GISC responsibility zone.

Now the radar base data of Hong Kong Observatory which is offered by Guangdong Meteorological Bureau includes two radar sites (Guangzhou and Shenzhen), data transmission interval is 6 minutes.

What Hong Kong Observatory offers to Guangdong Meteorological Bureau is also the base data of weather radar, data transmission interval is 6 minutes yet.

In addition, the data mosaic of 10 radar sites(in which 9 radars belong to Guangdong province and 1 radar belong to Hong Kong) is made and sent in real-time to Hong Kong for the purpose of monitoring severe weather.

With the development of the data exchange between Guangdong and Hong Kong, realizing the data share, the cooperation of business domain (including radar retrieval wind field, radar 3-D mosaic, radar base data quality control, radar echo classifier, storm diagnosing and tracking, the first strike of cloud-to-ground flash) has been gradually strengthened, promoting the nowcasting system.

6.3 Sino-ROK data exchange

China and South Korea began to exchange radar data in 2012, the exchange is done by the Sino-ROK special bilateral line according to the norm of GTS, no regional governance protocols. At present, according to bilateral agreement , the radar data transmitted from China to South Korea includes 5 kinds of products from 6 radar sites (i.e. Yantai, Qingdao, Dalian, Yingkou, Tianjin and Shenyang), the products are Reflectivity, Composite Reflectivity, Velocity, Vertical Integrated Liquid (VIL) and one-hour precipitation respectively. But the Yantai radar data have not been exchanged yet. The data are offered by GIF format. During non-flood season, the exchanged time is from 10:00 to 15:00(not including 15:00), During flood season, the exchanged time is from 1st,June to 31st ,August in TianJin and Dalian radar sites, for another 4 sites is from 1st, May to 30th September. The frequency of data transmission is once per hour and the requirement of transmitting timeliness is 10 minutes.

The radar data transmitted from South Korea to China includes one product from 10 radar sites, which is CAPPI. The frequency is once per hour and the requirement of transmitting timeliness is 10 minutes.

Carrying out the Sino-ROK bilateral exchange and realizing data sharing is very helpful to improve the prediction of typhoon and other severe weather. Fig.7 shows the coverage of China and South Korea adjoining areas at 1500 m and 3000 m heights above sea-level.

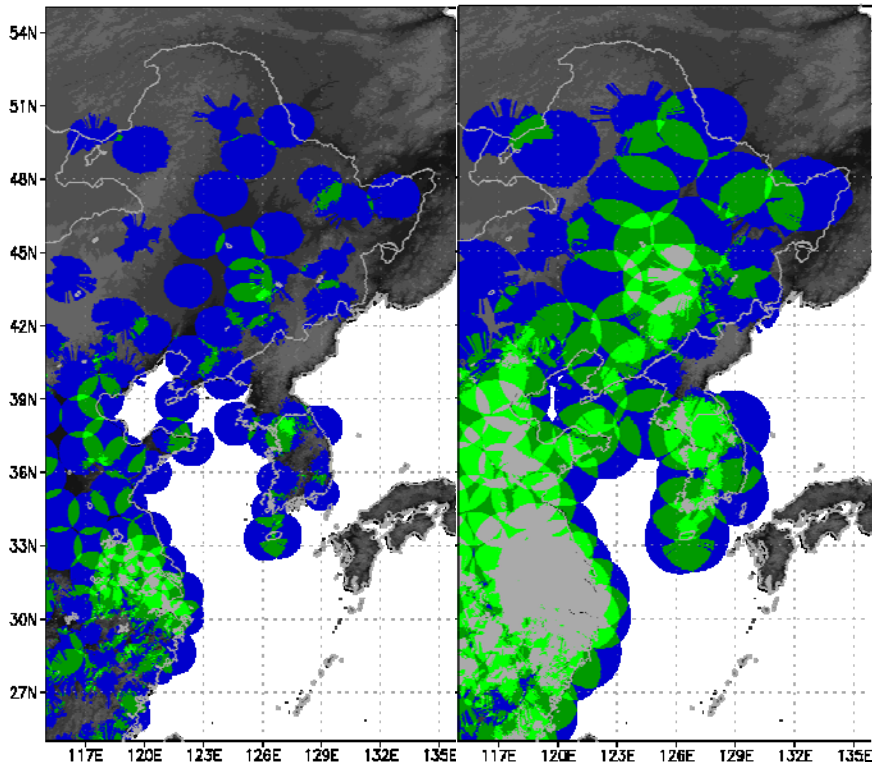


Fig.7 Radar coverage at 1500 m and 3000 m heights over Sino-ROK neighboring regions

6.4 **Data exchange between China and North Korea**

At present, according to bilateral agreement , the data transmitted from China to North Korea includes several kinds of products from 3 radar sites(i.e.,Shen Yang, Qing Dao and Da Lian), the products are FengYun-II satellite data, Monthly Dynamic Model Product, Hydrological Station Information and so on. During non-flood season, the exchanging time is from 10:00 to 15:00(not including 15:00),The frequency of data transmission is once per hour and the requirement of transmitting timeliness is 10 minutes.

7. Some important issues to be discussed

7.1 The data exchange strategy should be set by different service requirements

There are 3 critical factors for data exchange, i.e., huge data volume, high transmission frequency and timeliness. Weather radar data can be divided into three levels, which are IQ data (Level-I), base data (Level-II) and the product data (Level-III). No matter global data exchange or regional data exchange, the data exchange costing time should be decided based on different operational users. Currently high transmission frequency for nowcasting should be addressed while low transmission frequency for NWP should be required(if the exchange data is used in NWP, the frequency should not be very high, but if used in nowcasting, the frequency should be high due to small transmitting quantity). The best way is to analyze and evaluate the different requirements of data exchange carefully, and provide the requirements of content and timeliness of regional and global data exchange respectively.

The volume scan weather radar data is exchanged in domestic. By testing found that it takes more time to transmit data from radar site to provincial centers. So in order to improve the timeliness of radar data exchange, we suggest that data transmission should be done by using radial data flow, which means “uploading while scanning”.

7.2 Establishing feasible data format is crucial to data exchange

With respect to future radar technology development, e.g., polarization technique, some redundancy should be considered for data format. To transmit and store global data conveniently,

detailed definitions of data structure and format at each level should be provided, then requiring all the related countries and regions to carry out according to the same definitions.

7.3 The Quality Control scheme should be unified by WMO

The quality control of radar data is carried out for IQ data (Level-I), base data (Level-II) and product data (Level-III). The IQ data volume is so large that quality control needs to be done at radar sites. Now lots of quality control work has been done for base data (Level-II), but some problems still exist(such as how to improve the quality of data, remove ground clutter or Anomalous Propogation, solve the problem of range folding and velocity ambiguity and remove the interference and wave clutter, etc). Meanwhile, for different products, the QC methods are different. Therefore, to ensure the accuracy of radar data, we suggest WMO organize experts to do investigations and analyses and put forward a unified quality control scheme according to the different situation in different countries. What is more, unified calibrating methods should be developed to ensure the homogeneity of the data from the different types of radar in the process of regional and global data exchanges. If the exchange of base data involves issues of data policies in different countries, the quality control should be done at Level-III, and then fully implementing it after all the countries reach an agreement.

WRDE Report: Status of Radar Data Exchange in Region II

LI Bai
20130408

Introduction

The terms “Asia Region”, “Asia”, “RA II” and/or “the Region” are used to describe the area englobing the countries and territories encompassed in the WMO Regional Association (RA) II (Asia). There are 35 Members of RA II.Table 1 shows the list of Region II countries retrieved from the WMO web site. Information was derived from a internet search of NHMS web sites.

Table 1: List of Region II members

Country	Web Site	WRDB	WEB	Radar
Cambodia	Department of Meteorology		yes	yes
China	China Meteorological Administration		yes	yes
Democratic People's Republic of Korea	State Hydrometeorological Administration		no	yes
Hong Kong, China	Hong Kong Observatory		yes	yes
India	India Meteorological Department		yes	yes
Japan	Japan Meteorological Agency		yes	yes
Lao People's Democratic Republic	Department of Meteorology and Hydrology		yes	yes
Macao, China	Meteorological and Geophysical Bureau		yes	yes
Maldives	Department of Meteorology		yes	yes
Pakistan	Pakistan Meteorological Department		yes	yes
Republic of Korea	Korea Meteorological Administration		yes	yes
Sri Lanka	Department of Meteorology		yes	yes
Thailand	Thai Meteorological Department		yes	yes
Viet Nam	Hydrometeorological Service		yes	yes
Bahrain	Bahrain Meteorological Service		yes	no
Bangladesh	Bangladesh Meteorological Department		yes	no
Bhutan	Council for Renewable Natural Resources Research		yes	no
Myanmar	Department of Meteorology and Hydrology		yes	no
Nepal	Department of Hydrology and Meteorology		yes	no
Qatar	Civil Aviation Authority		yes	no
United Arab Emirates	Meteorological Department		yes	no
Uzbekistan	Uzhydromet		yes	no
Yemen	Yemen Meteorological Servic		yes	no
Iran, Islamic Republic of	Islamic Republic of Iran Meteorological Organization		yes	???
Iraq	Iraqi Meteorological Organization		yes	???
Kazakhstan	Kazhydromet		yes	???
Kuwait	Department of Meteorology		yes	???
Kyrgyzstan	Main Hydrometeorological Administration		yes	???
Oman	Department of Meteorology		yes	???
Russian Federation	Russian Federal Service for Hydrometeorology and Environmental Monitoring		yes	???
Saudi Arabia	Presidency of Meteorology and Environment		yes	???
Mongolia	National Agency for Meteorology, Hydrology and Environment Monitoring		no	???

Tajikistan	State Administration for Hydrometeorology	no	???
Turkmenistan	State Administration of Hydrometeorology	no	???
Afghanistan	Afghan Meteorological Authority	no	???

The “radar” column is to indicate whether radars are evident.

Information Requirements

Information was sought on the following:

- radars in the NHMS
- The numbers of radar within the country (intra)
- products or raw data exchanged
- mosaiced either in intra/inter
- why/why not and limiting factors

Information Gathering

Internet Search

Links to the NHMS web sites are incorporated in the WMO web site. If the web site pages cannot connected/linked, then this is recorded in column 2 of Table 1. If the web site indicate the presence of radar, this is recorded in column 3 of Table 1. This provides a first order indication whether (i) there are radars available to the NHMS (belonging to NHMS, accessible by NHMS), (ii) if mosaics are available, this indicates whether intra-NHMS data exchange is occurring (iii) or inter-NHMS data exchange is going on,

This does not necessarily indicate that if data exchange is going on since there may be proprietary issues preventing this. Also, this does not necessarily the best web site as the radar data exchange may be better expressed on other web sites (like NCDC or NEXRAD). Also, radars and the data may not be proprietary to the NHMS but owned by transport (aviation) or utilities (hydro-electric)

Web site URL, emails, contact names and phone numbers for follow-up were extracted.

Email

Using the available email contacts (many were very generic), emails were issued to request more information about radar data exchange. Response was not plentiful but very fruitful.

Phone Contact

No phone calls were made (as of this writing) due to time but also due to potential oral language issues.

Comments/Results

The comments column in Table 2 represent the results of this analysis and is the current status.

Country	**External Exchange**
Cambodia	One Radar Station TECHO SEN, located in Phnom Penh, began on 25th of March 2011 and was completed 11 months later on the 15th of February 2012. The height of the hexagonal building is 50.60 m (for a total height of 60.60 m if one includes the radar protection ball). It has a diameter of 24.48 m, 13 floors with 5 dedicated to offices and to the weather prediction center. The station is operational since the 4th of April 2012.
China	plan 216 radars in future, now deployed 178 radars. Exchaged radar data with Republic of Korea, Hong Kong, Macao, and so on.
Democratic People's Republic of Korea	two weather radars
Hong Kong	3 Doppler weather radars(one for aviation)
India	14 S-band, 11 out of 14 S-band radars used for cyclone detection, 2 S-band used for storm detection, 1 radar used for training&testing purpose. 25 X-band,9 out of radars used for Storm detection and 16 for wind finding. All the wind finding radars also have the facility for weather observations. 5 radars out of 39 radars including S-band and X-band are upgraded to Doppler Weather radars, 34 more radars will be equipped with Doppler and dual polarization capability. Two C-Band The raw data is converted to NetCDF, HDF5, UF and BUFR Oper for assimilation into NWP models and for ingesting in SYNERGY system supplied by MFI. 2010's
Japan	JMA's network of 20 C-band radars (with a wavelength of 5.6 cm) covers most of Japan's territory and observes rainfall intensity and distribution. 16 upgraded to Doppler radars, 4 conventional radars.
Lao People's Democratic Republic	1 weather radar
Macao, China	SMG X-band meteorological radar located over Taipa Grande is purposed for monitoring the reflected data of water vapor within the atmosphere of Macao and neighboring areas in order to reflect the rainfall situation within the observed areas
Pakistan	7 weather radars:Islamabad, Mangla , Dera Ismail Khan , Lahore , Rahim Yar Khan , Sialkot , Karachi.3 Doppler Radars: Lahore, Sialkot,Mangla
Republic of Korea	12 radars, two for aviation and research, gradually replace all of 10 operational single polarization radars with S-band dual polarization radars the period of 2013-2018 Cross-governmental radar integration including KMA(12 radars),MLTM(3 radars),MND(9 radars), National radar sharing rate:41.7%(2009),62.5%(2010),91.7(2011)
Thailand	14 TMD Radars : Chiang Rai, Lamphun, Phetchabun, Khon Kaen, Sakon Nakhon, Ubon Ratchathani, Surin, Suvarnabhumi, Hua Hin, Chumphon, Surat Thani, Phuket, Krabi, Songkhla. 2 RainMaking Radar : Omkoi and Pimai
Viet Nam	3 weather radars
Sri Lanka	It has a Radar Division, however it has the Upper-air data .
TaiWan	4 weather radars
Maldives	The Radar information is not available in the web site

Afghanistan	Nothing on web site
Turkmenistan	Nothing on web site
Mongolia	Bad web link
Tajikistan	Bad web link
Bahrain	No evidence of radar on web site (but see WMO)
Bangladesh	No evidence of radar on web site (but see WMO)
Bhutan	No evidence of radar on web site (but see WMO)
Qatar	No evidence of radar on web site (but see WMO)
Myanmar	No evidence of radar on web site (but see WMO)
Nepal	No evidence of radar on web site (but see WMO)
United Arab Emirates	No evidence of radar on web site (but see WMO)
Uzbekistan	No evidence of radar on web site (but see WMO)
Yemen	No evidence of radar on web site (but see WMO)
Iran, Islamic Republic of	???
Iraq	???
Kazakhstan	???
Kuwait	???
Kyrgyzstan	???
Oman	???
Russian Federation	???
Saudi Arabia	???

Summary

1 There are 35 members of RA II.
2 From the internet and Weather Radar database, there was evidence of weather radar in 12 countries
6 Raw radar data is exchanged in product format(GIF) between China and Republic of Korea since 2012.
7 The data exchange between Hong Kong and Guangdong province is mainly conducted by mosaic products.
7 There are 4 weather radars in Taiwan island, 5 C-band Dual-polarization weather radars will be constructed in the future, so the data exchange will be considered between China mainland and Taiwan island, the mosaic products will be mainly exchanged.

Draft 20130408/LB