Improving Surface-based Data Quality through Improved Standardization of Practice and Procedures

In Situ Observation Experience & Regional Needs

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Outline

- CMA Integrated Observation System Layout
- CMA's Experience in Quality Control of Surface-based Observation Data
- Suggestions from CMA

CMA Integrated Observation System Layout

Surface observation network operated by CMA

- **CMA 's surface-based observation have three levels ;**
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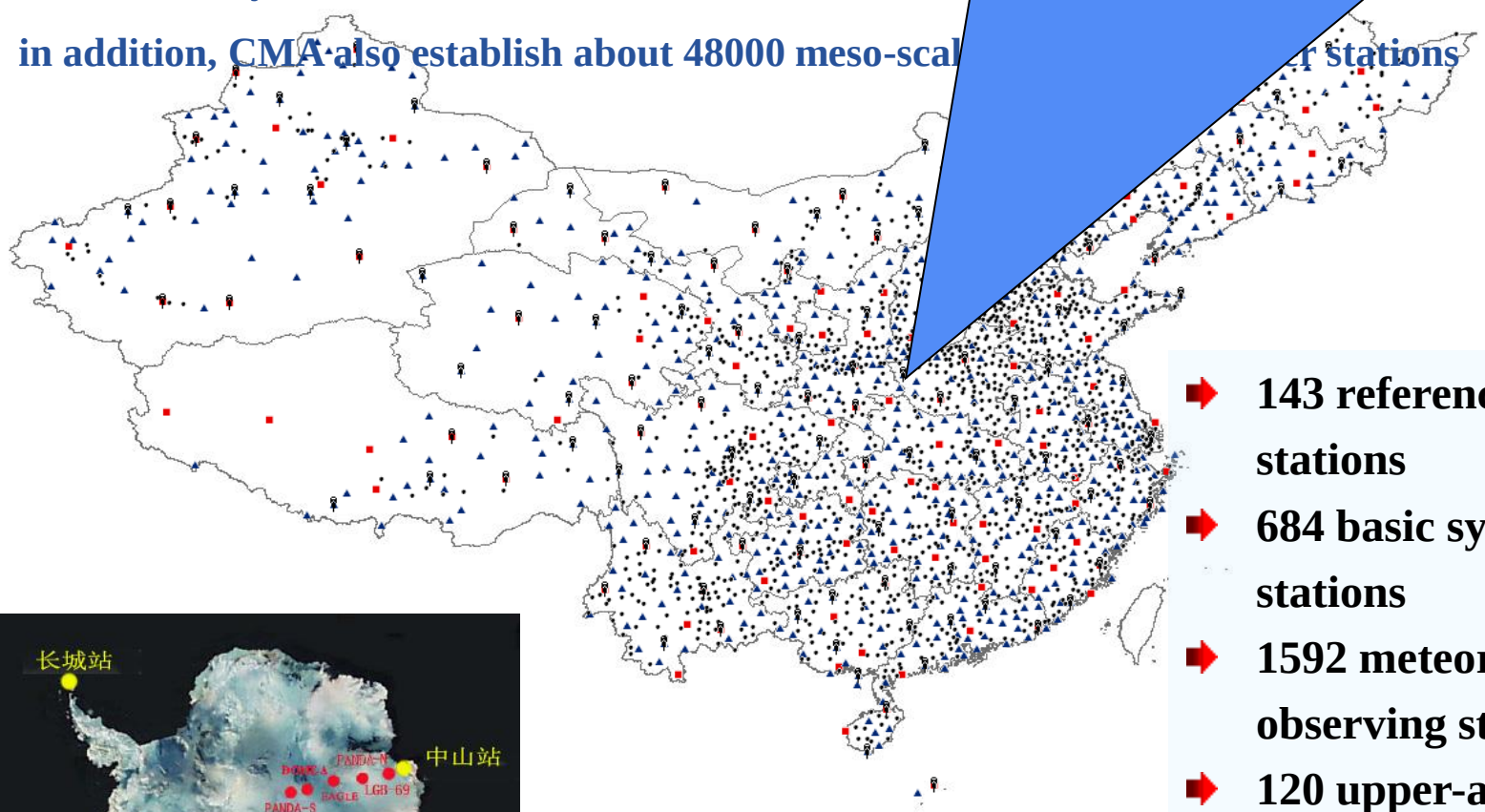
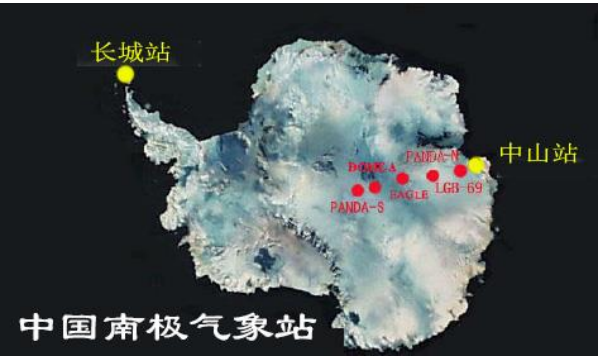
- **in addition, CMA also establish about 48000 meso-scal** **r stations**

So far, CMA has established a surface observation network consisting of about 50000 automatic weather stations of various elements.



- **143 reference climate stations**
- **684 basic synoptic stations**
- **1592 meteorological observing stations**
- **120 upper-air observing stations**



Total： 2419 stations

Observation elements for automatic weather stations

Temperature and humidity

Precipitation

Evaporation

Ground temperature

Radiation

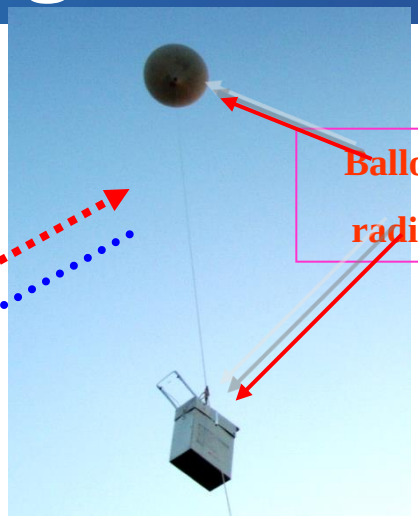
Terminal for data processing

L-band automatic sounding

Detection instrument：750g balloon with L-band radiosonde

Surface instrument：L-band secondary radar

Auxiliary instrument：Based test box， hydrogen production equipment by electrolysis



Transmitted signal

Returned signal

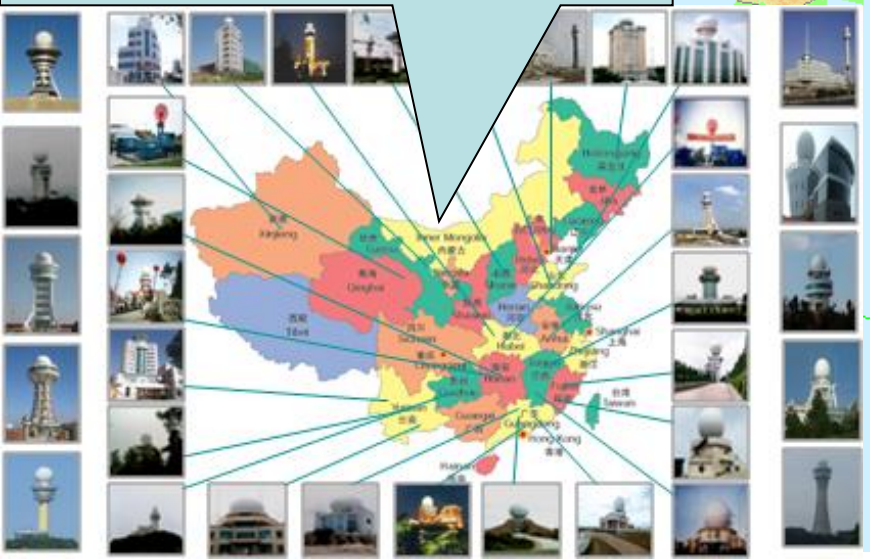
Radar system

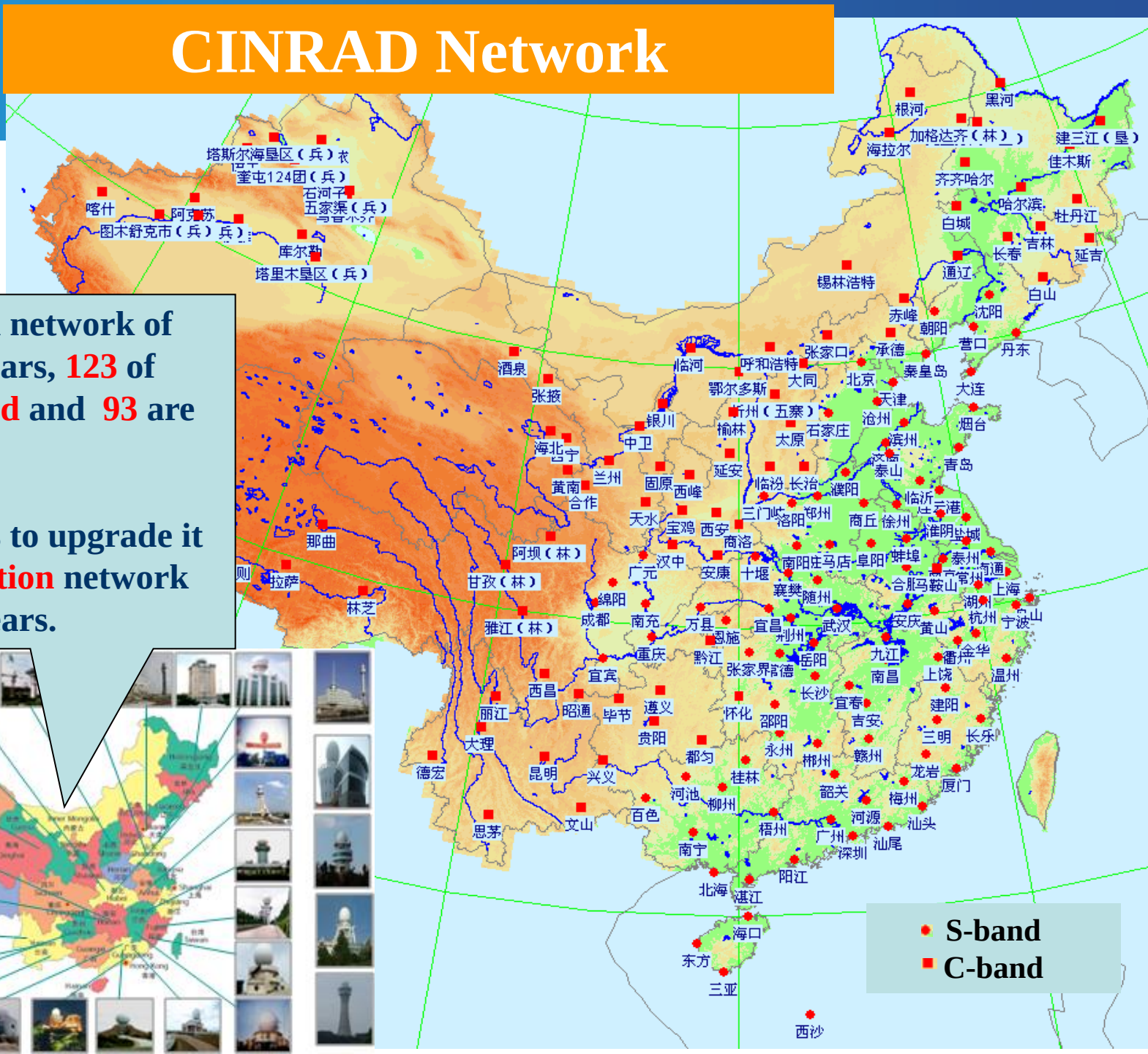
Data processing system

CINRAD Network

CMA operates a network of **216** weather radars, **123** of which are **S-band** and **93** are **C-band**.

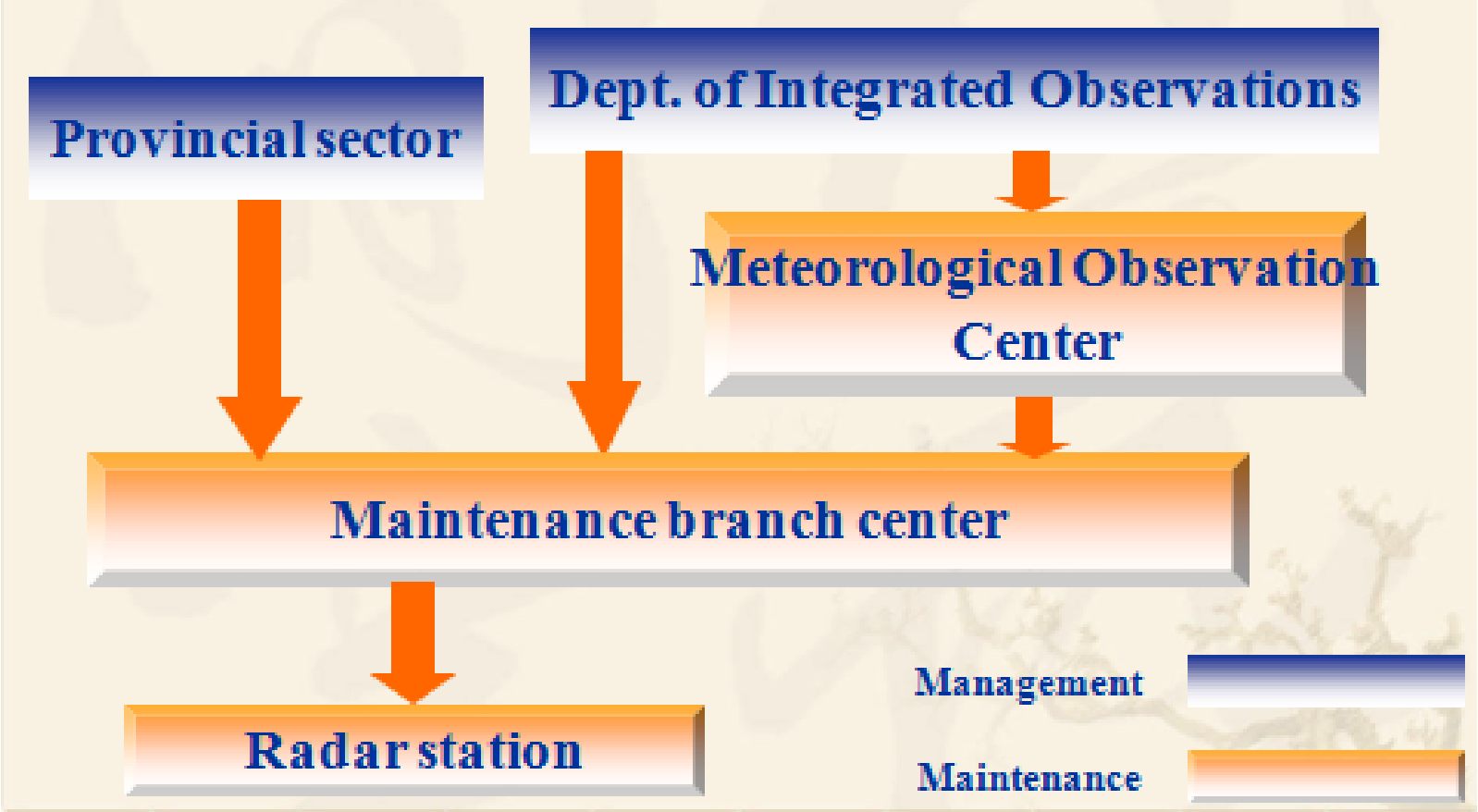
And CMA plans to upgrade it to **dual-polarization** network in the next 10 years.





CINRAD Maintenance System

- **Two-Level Management : National and Provincial level managment**
- **Three-Level Maintenance : National, Provincial and Radar site three levels**



Wind Profiler Radar Network in China

- **Plan to build 186 wind profilers, most of which have a detection height of 8km.**
- **Site interval of 100-200km in east , central and south of china where are frequent heavy rainfall, strong convection, and haze.**
- **Establish four regional experiment networks to meet operational requirements and technological development. (By four regional experiment networks ,to establish standards, operational procedures etc.)**

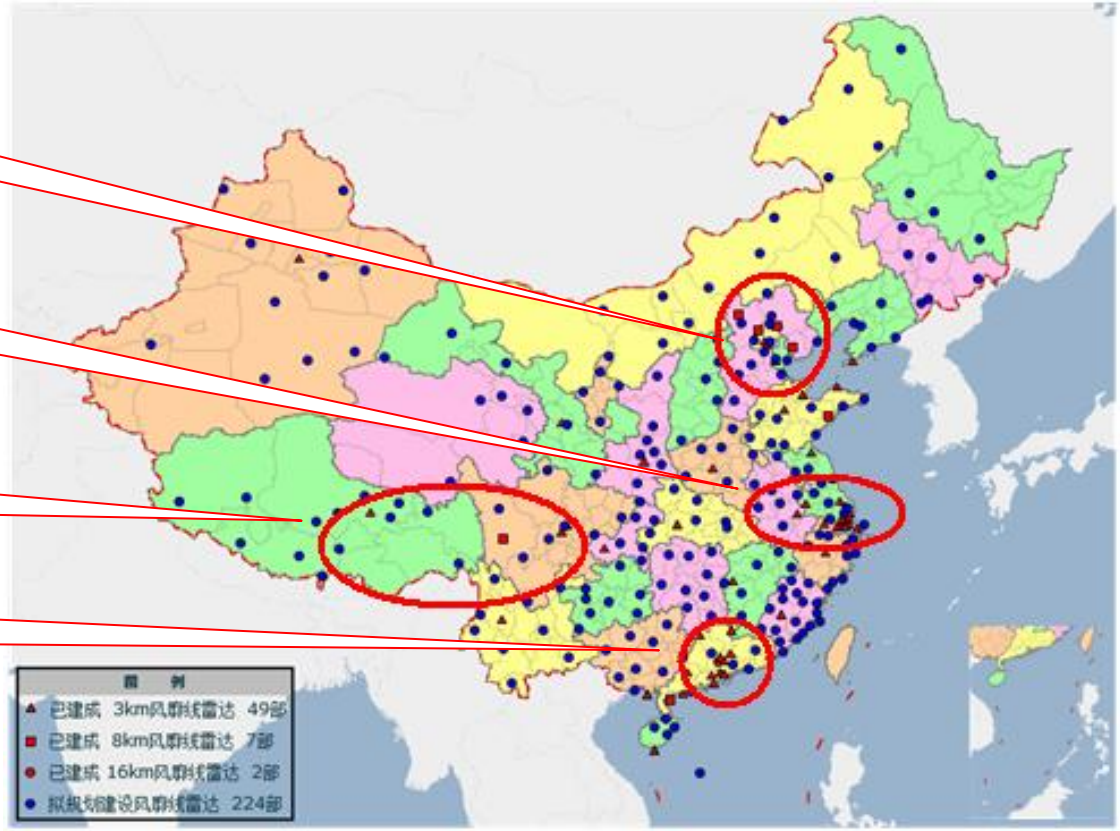
Four Experiment network

Beijing–Tianjin-Hebei Network

Yangtze River Delta Network

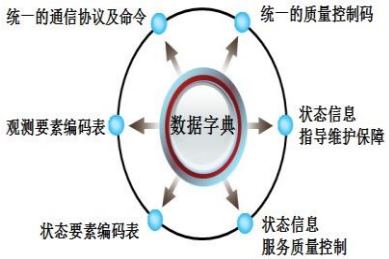
Sichuan–Tibet Network

Pearl River Delta Network



CMA’s Experience in Quality Control of Surface-based Observation Data

1. Standardizations on surface observations

	Actions	Function and benefit
	We establish “Instrument Requirements Definition ”which standardizes the main performances , technical specifications, function requirements, etc., of the meteorological instruments, meanwhile, we set strict examination before they are put into use.	Standardize meteorological instruments, which makes management and training easier
	We establish “Data Dictionary ”which standardize the variable name, device status name , communication protocol, data format and so on during data transfer.	Standardize communication which makes the system stable and easy to use
	We establish a “Device Controller” which allows all instruments in a station to be accessed and controlled by the standardized interface and control instruction	Standardize integrated system which makes the station more flexible

1. Standardizations on surface observations

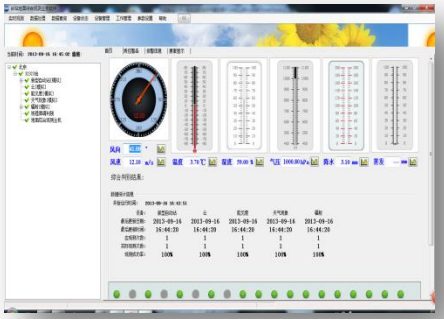
Actions

An organization, named "**National Technical Committee 346 on Basic Information of Meteorology of Standardization Administration of China(SAC/TC346)**", establishes rules and regulations to standardize meteorological operations in China.

Function and benefit

Effective and authoritative

SAC/TC346 enable effective work on standardization in China



A software named "**Integrated Surface Observing System (ISOS)**" enables observer to finish their daily routines, and the software is applied to all stations.

Easier and fewer error

ISOS standardize work as system monitoring, operation managing, equipment maintenance, etc.

A standardized data quality control system is widely used which contains checks for value, temporal consistency, spatial consistency, internal consistency, extended quality control, human interface and so on.

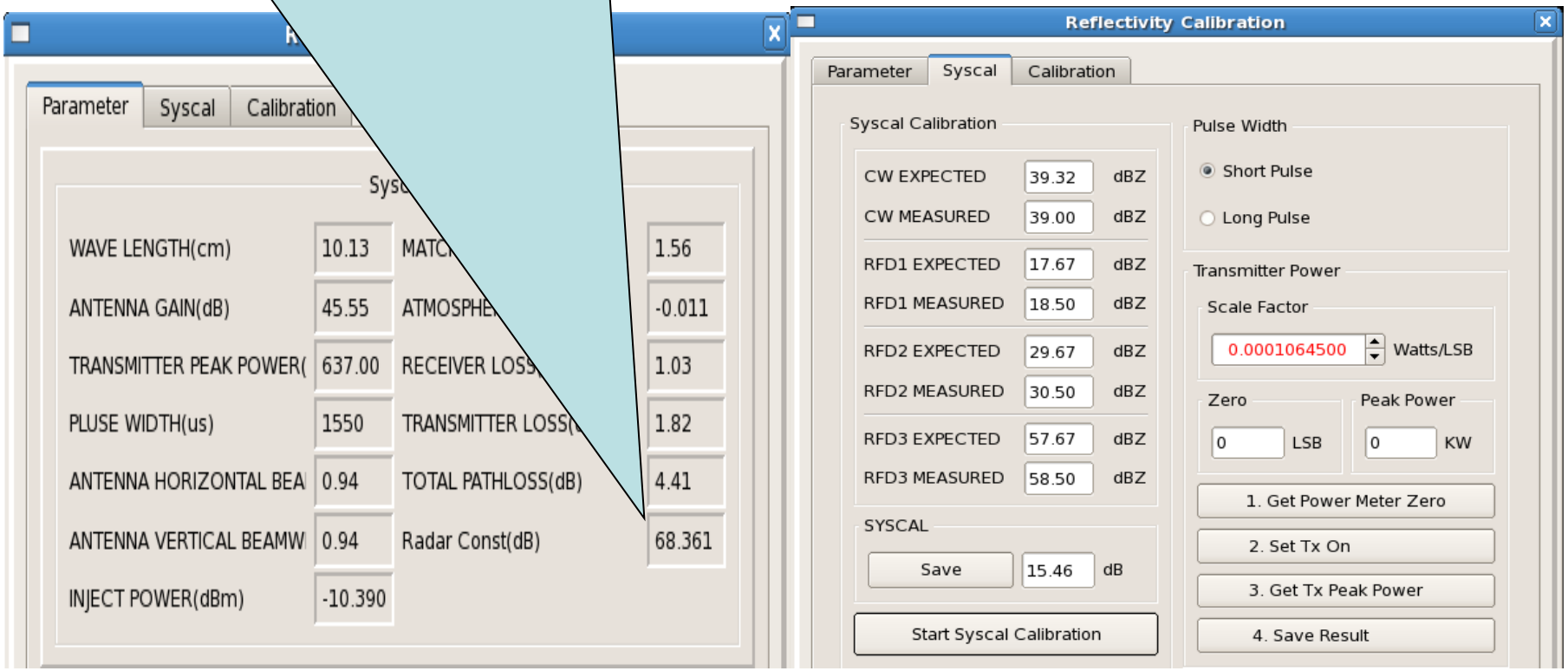
Reliable

Sophisticated data QC at sensor, station, data center and national data processing center produces more reliable datasets

2. Standardizations on Weather Radar

- **Establishing standardized test and calibration procedure is important to ensure data comparability and consistency for weather radar observation network.**

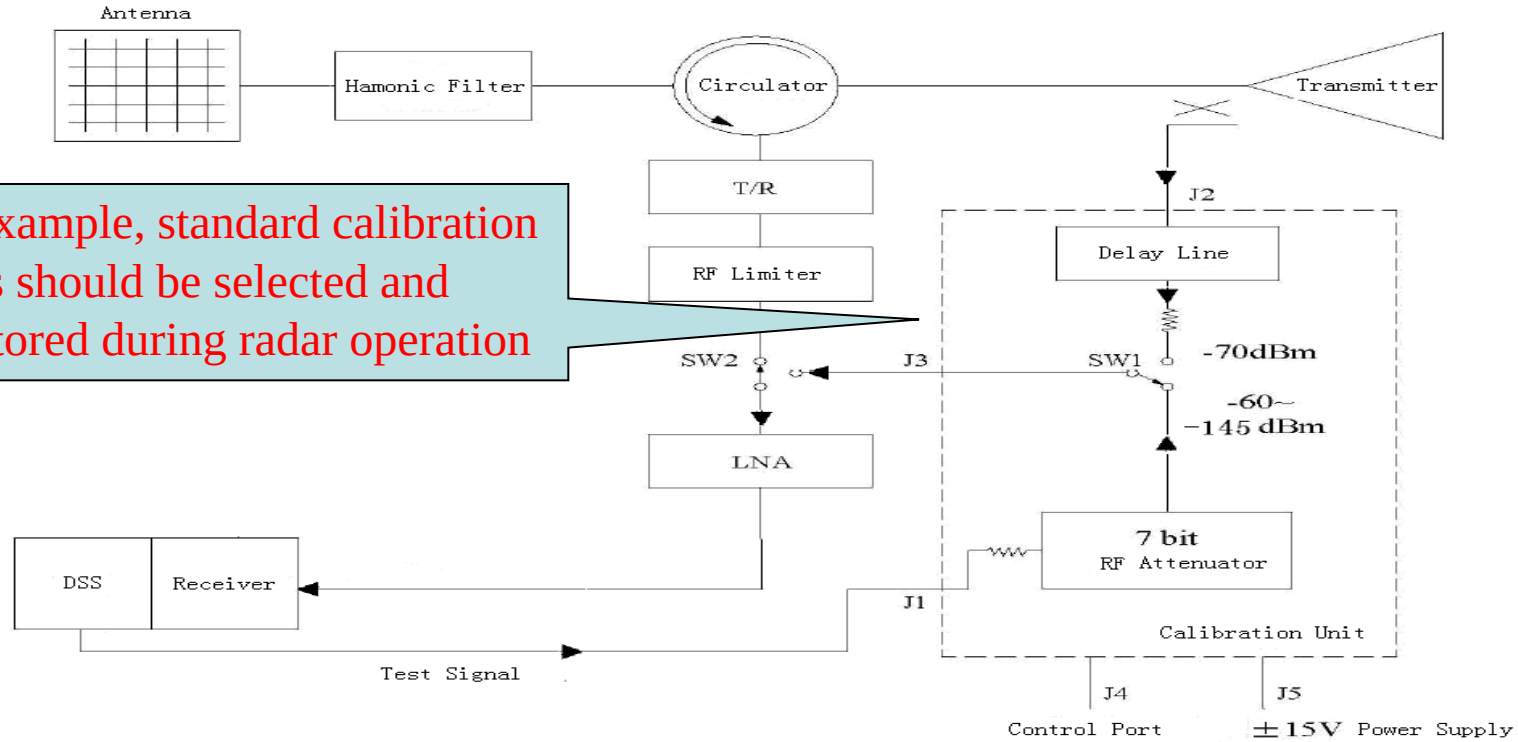
For example, radar constant includes key parameters in transmitter, receiver, antenna and should be monitored and calibrated at the end of every volume scan.



2. Standardizations on Weather Radar

- **As ground-based observation network develops towards remote measuring and remote sensing, therefore ,standardized test and calibration is becoming more and more important for improving radar data quality.**

For example, standard calibration nodes should be selected and monitored during radar operation

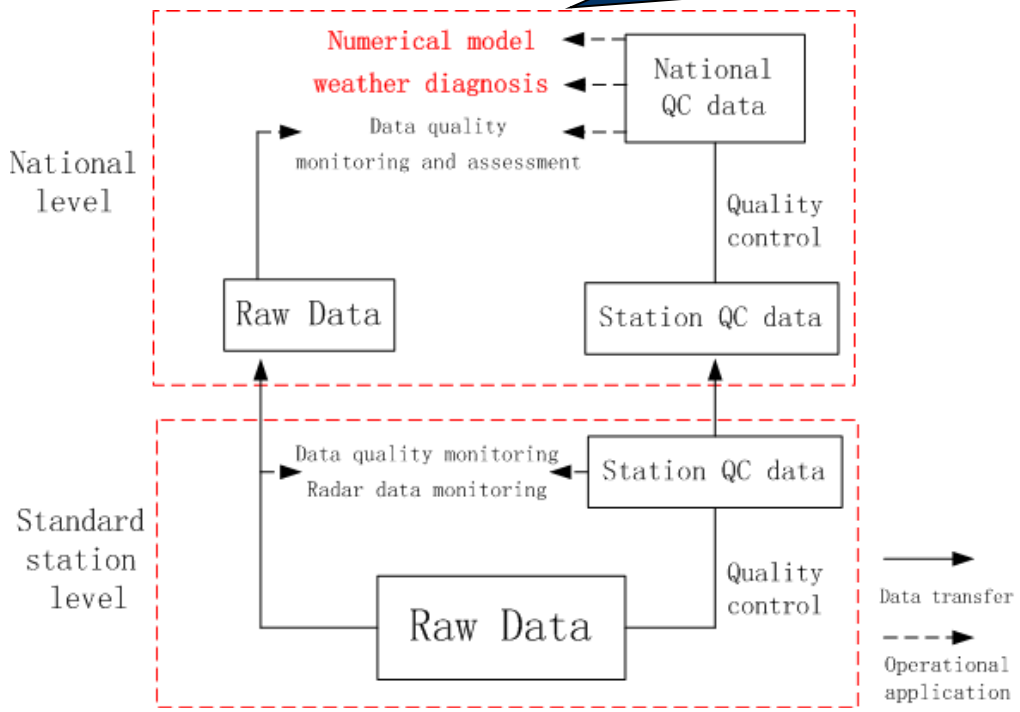


Block diagram of radar calibration unit in China

3. Standardizations on Wind Profiler

Establish unified and standardized quality control(QC) workflow for wind profilers:

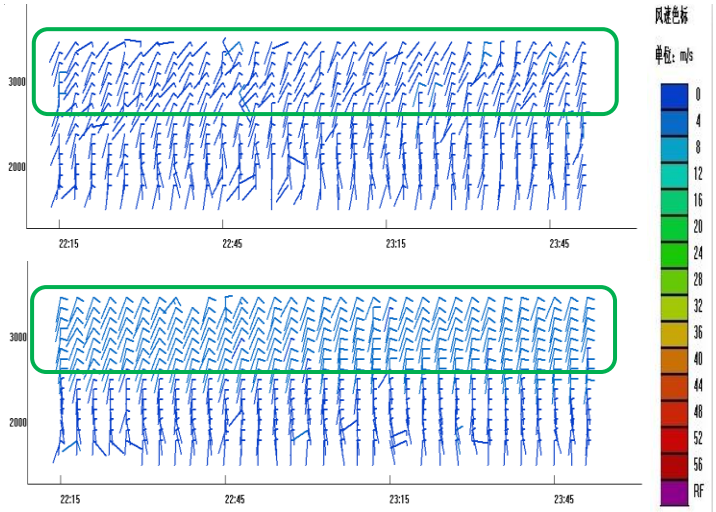
- **Ensuring consistency and accuracy of the wind profiler data.**
- For example, precipitation influences the accuracy of wind measured by wind profiler radar. For NWP, precipitation interference should be rejected. But for weather diagnosis, precipitation and wind information should be retained.



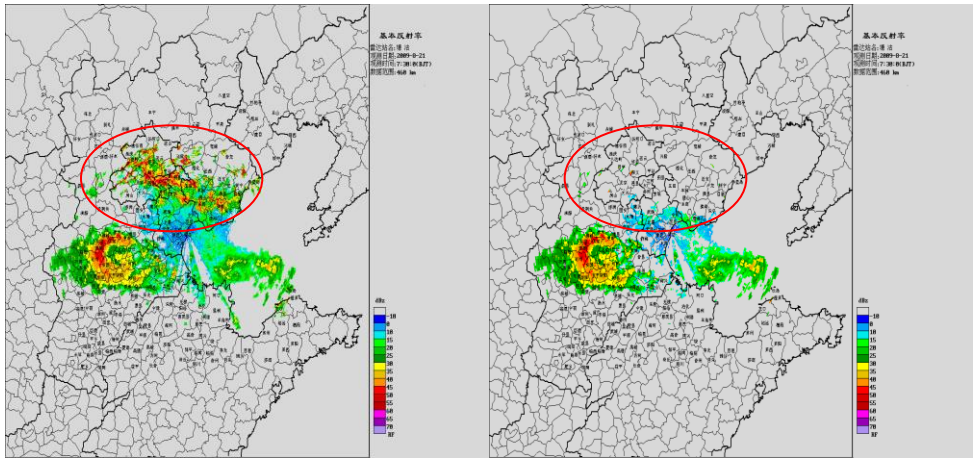
Operational QC workflow for wind profiler radar in China

3. Standardizations on Wind Profiler

- **Different observation data have various quality control methods for different application nodes. For some information, they should be eliminated in some application node while need to be maintained in another application node.**



Demonstration of bimodal spectrum identification QC technology of wind profiler radar in precipitation. The wind direction in green box is more consistent and reasonable after QC(lower) than before(upper).



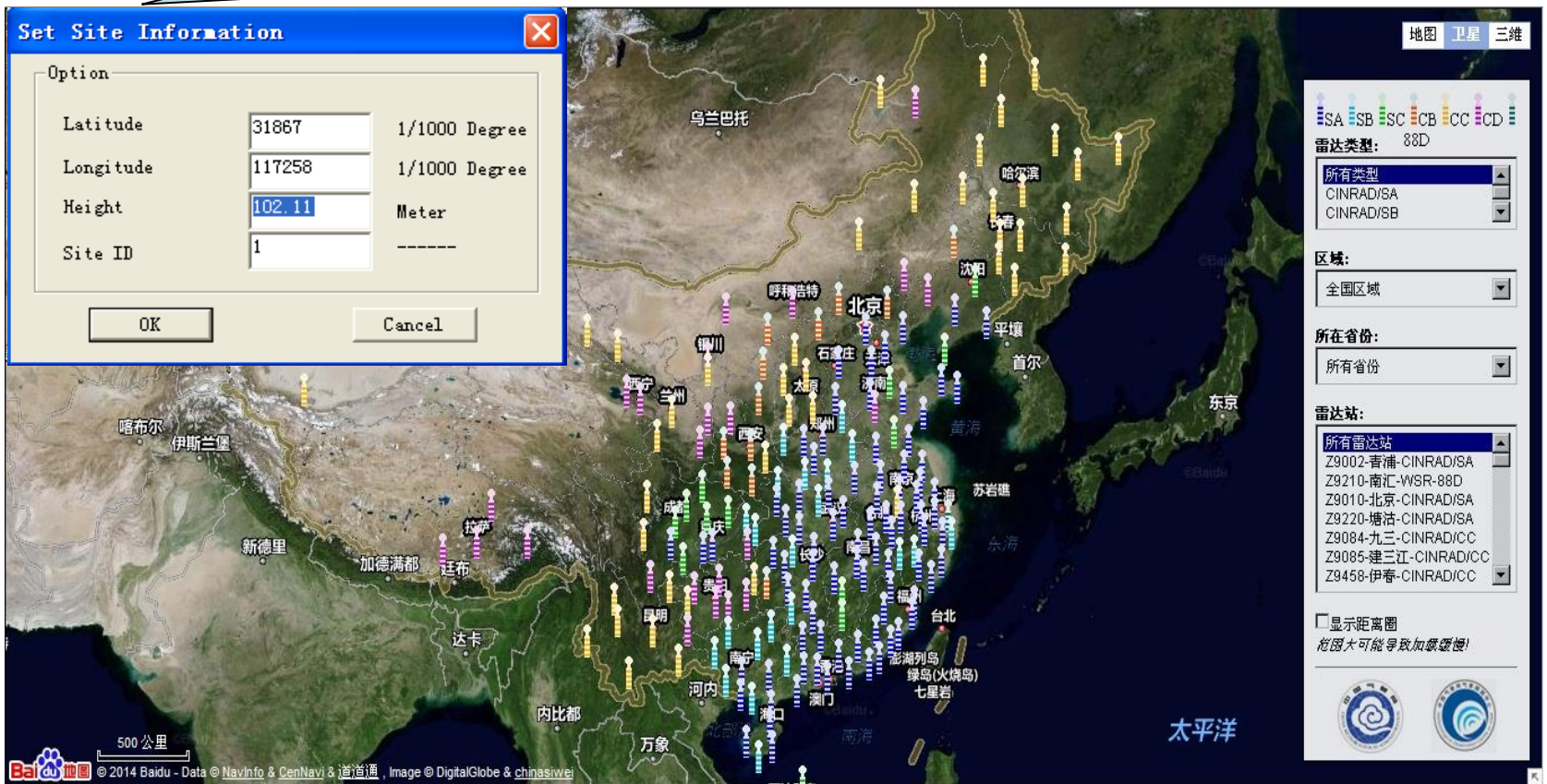
Super-refraction(red circle) for weather radar observation before(left) and after (right) quality control.

For example: Super refraction echo can be used to analyze weather conditions such as atmospheric stratification but it must be removed in quantitative estimates of precipitation

4. Standardizations on Metadata

◆ **Establish unified metadata standards for weather radars and wind profilers in order to improve data quality.**

For example, metadata such as radar coordinates, elevation, main configuration parameters, observation mode, data processing and quality control method, etc will have a significant impact on observation data quality.



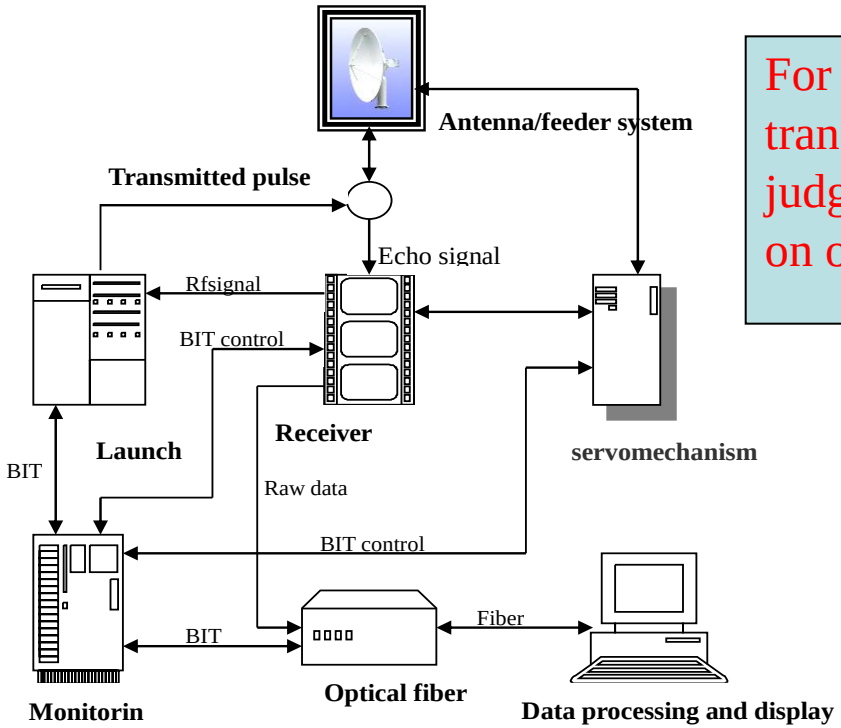
5. Standardizations on Operational Monitoring

We have established Atmospheric **O**bserving **S**ystem **O**perating and **M**onitoring-ASOM platform. Up to now , ASOM can monitoring the integrated meteorological observation equipments as follow:

- **172 CINRADs**
- **120 Upper-air stations**
- **40 Wind profiler radar**
- **2418 National Surface AWS**
- **601 GPS/MET**
- **315 Lightning stations**
- **1866 Soil moisture Station**
- **……**

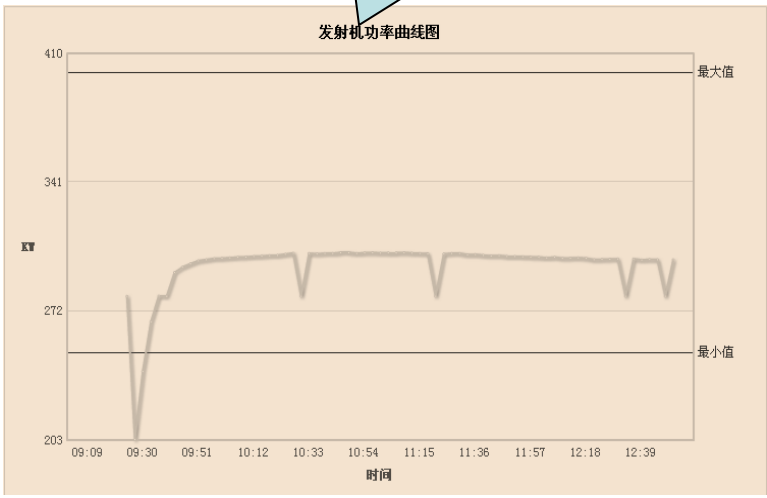
5. Standardizations on Operational Monitoring

- **As the status information is very important evidence for establishing data quality control methods, we should consider it as a crucial index for equipment performance.**

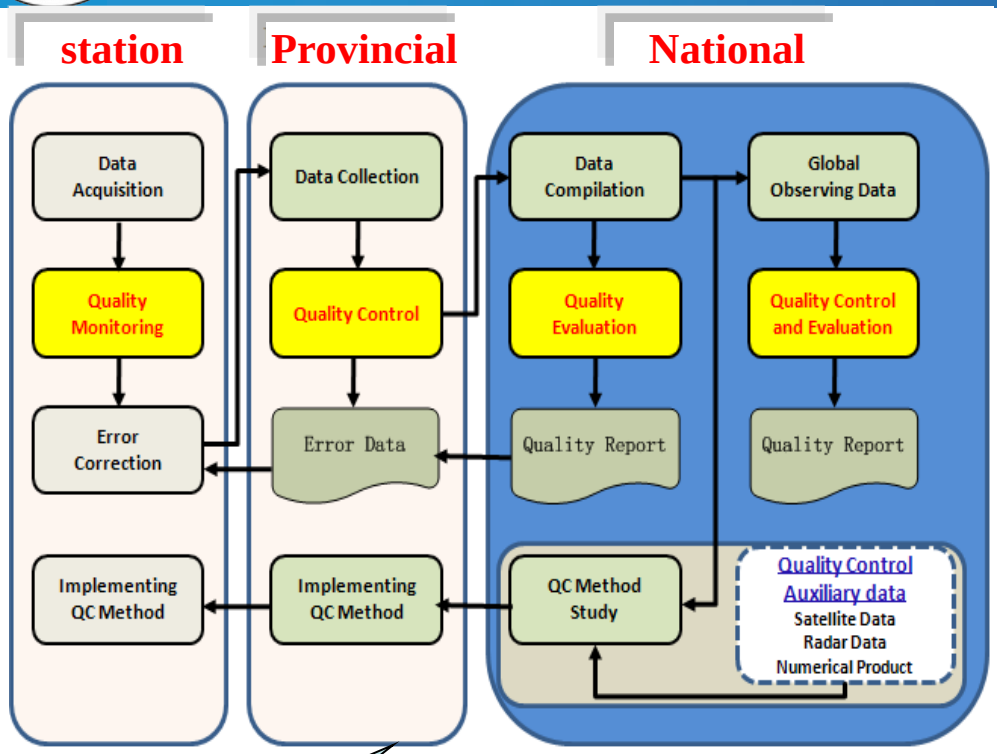


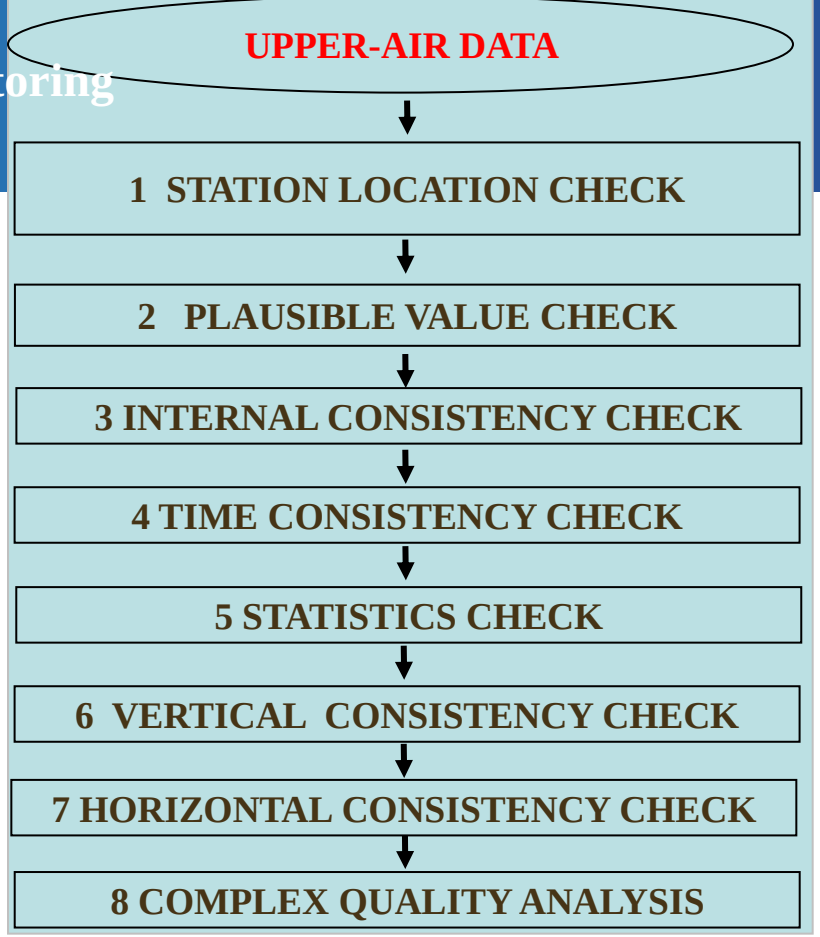
Radar monitoring points design

For example, by monitoring the variations in transmitted power of weather radar , we can judge radar performance and analyze its effect on observation data quality.

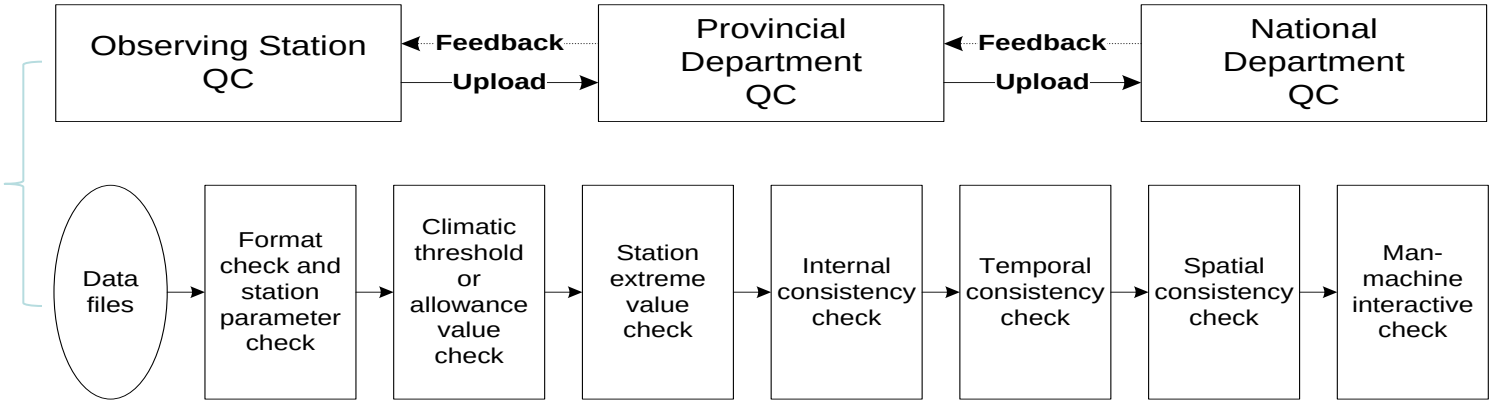


5. Standardizations on Operational Monitoring





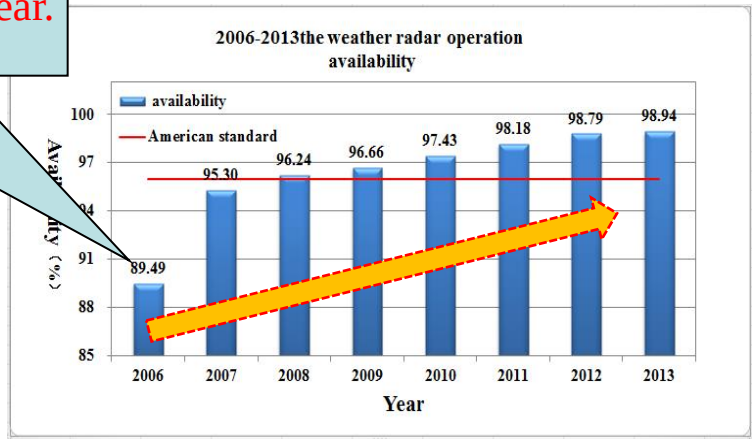
These diagrams depict quality control flowcharts for surface and upper-air observation data.



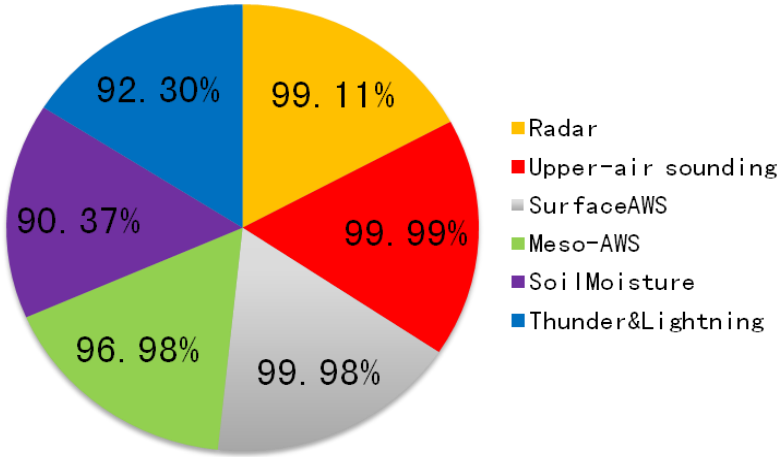
6. The Benefit and Achievement on Operational Monitoring

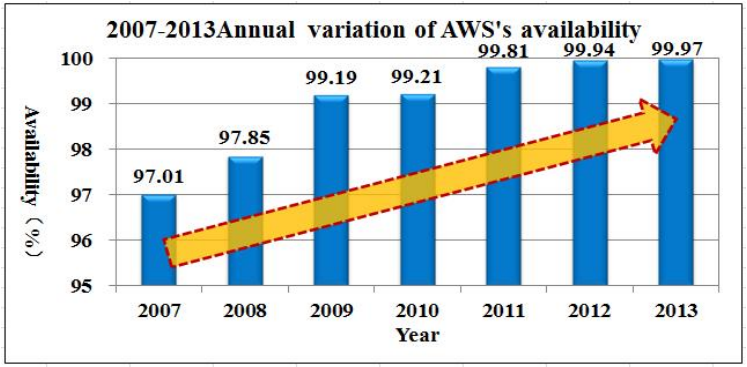
- **Establish standard and unified software system**
  - Operational Monitoring
  - Help Desk and
  - Operational E
  - Information Release

As you can see, the operational availability for radar and AWS in China improves greatly year by year.

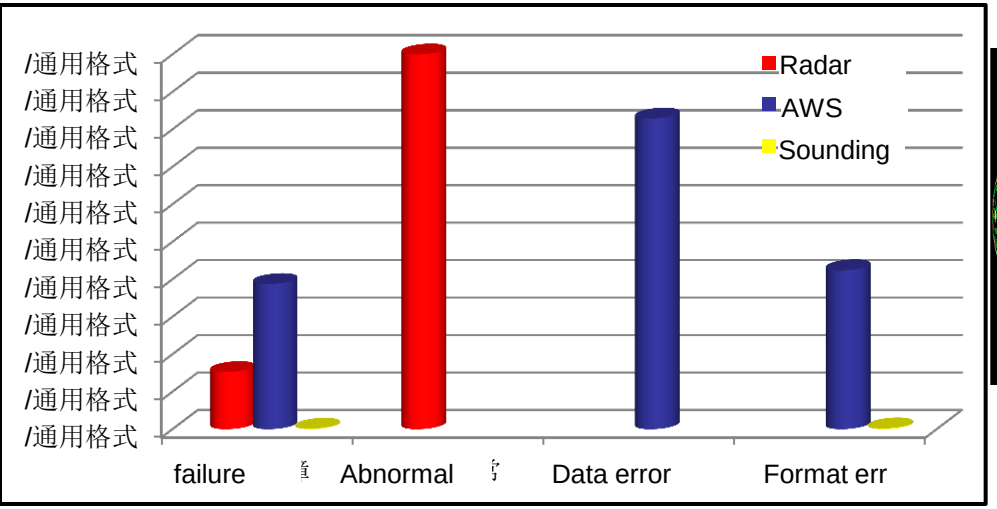


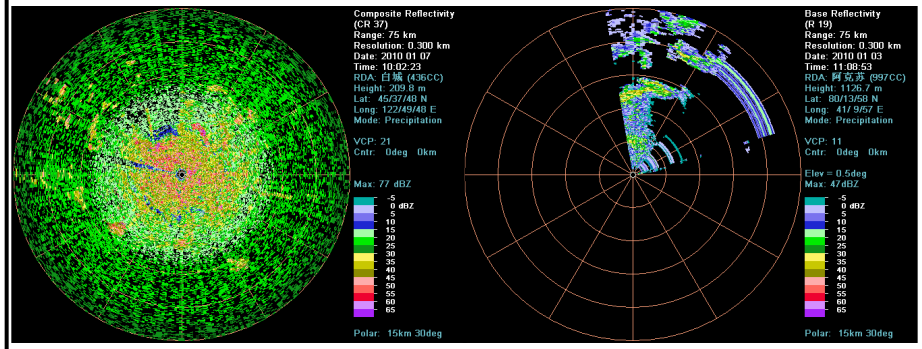
Availability During 2014.1-2014.10

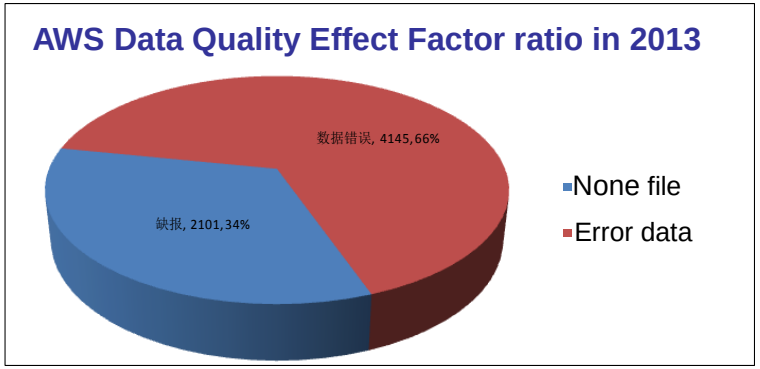




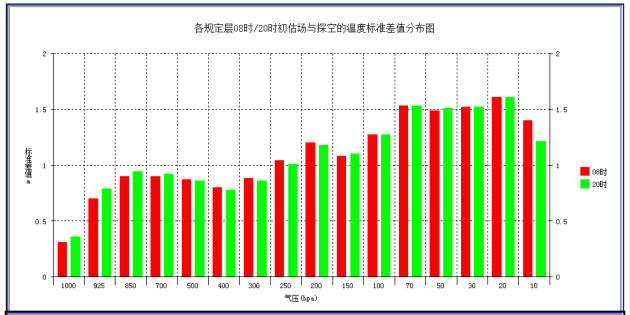
6. The Benefit and Achievement on Operational Monitoring

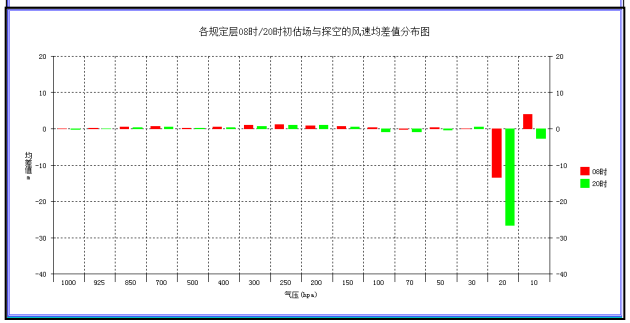




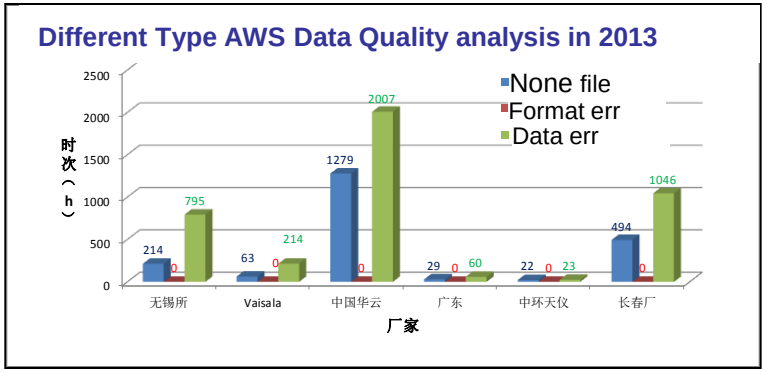


We also conduct statistical analysis and evaluation for observation data quality





Sounding Temp. and Wind Velocity Data Err in 2013



Statistics in 2013:

- **Radar abnormal data: 30000;**
- **National surface AWS error data: 4145**
- **Upper-air sounding failure: 8**

- **Suggestions from CMA**

Suggestions from CMA

- **1. Establishing operational status information standards for surface-based observation instrument and equipment, can improve the observation data quality, and hence should be made as an important performance index for instrument and equipment themselves.**

  It is necessary to establish status information standards and specifications for various ground-based observation instrument and equipment, in order to improve data quality. As status information is important evidence for establishing data quality control methods, we should consider the instrument and equipment outputs as crucial indexes for their performance.

- **2. Establishing standardized equipment test and calibration is important to ensure data comparability and consistency for observation network.**

  As ground-based observation network develops towards remote measuring and remote sensing, standardized test and calibration is becoming more and more important for improving data quality.

Suggestions from CMA

- **3. Establishing unified and standardized quality control methods for observation data in various application nodes is important to improve data availability and accuracy.**

Different observation data have various quality control methods for different applications. For some information, they should be eliminated in some application node while need to be maintained in another application node, such as interference of precipitation on wind profiler, and super-refraction for weather radar observation.

Suggestions from CMA

- **4. Establishing metadata standards for the surface-based remote sensing observation network (such as weather radar network, wind profiler radar network, prospective microwave radiometer network, etc.) is an important foundation for improving data quality of surface-based observation.**

With the development of integrated meteorological observation network towards the direction of remote sensing technology, a large number of surface-based remote sensing equipment and instrument will enter the integrated meteorological observation network in future. To make and establish unified and standardized metadata standards of surface-based remote sensing observation, not only relates to the observation data quality, but also affect applications in weather forecast operation and numerical forecast model.

For weather radar network, basic information such as radar coordinates, elevation, main configuration parameters and observation mode, data processing and quality control methods and so on, all of these will have a significant impact on the quality of weather radar observation data. Therefore, under the background of global weather radar data exchange, CIMO should make and establish a unified standard in order to ensure reliability and standardization of surface-based remote sensing observation data from different countries and further promote the application of surface-based remote sensing data in meteorological operations, especially in the numerical forecast model.

Thank you for your attention!