

# Case study using total lightning data for some severe thunderstorms during the 2010 Shanghai Expo period

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ST2011, Jul. 13, 2011, Norman OK



# Outline

1. Lightning activity in Shanghai
2. The World EXPO 2010, Shanghai, China
3. Cases
4. Summary

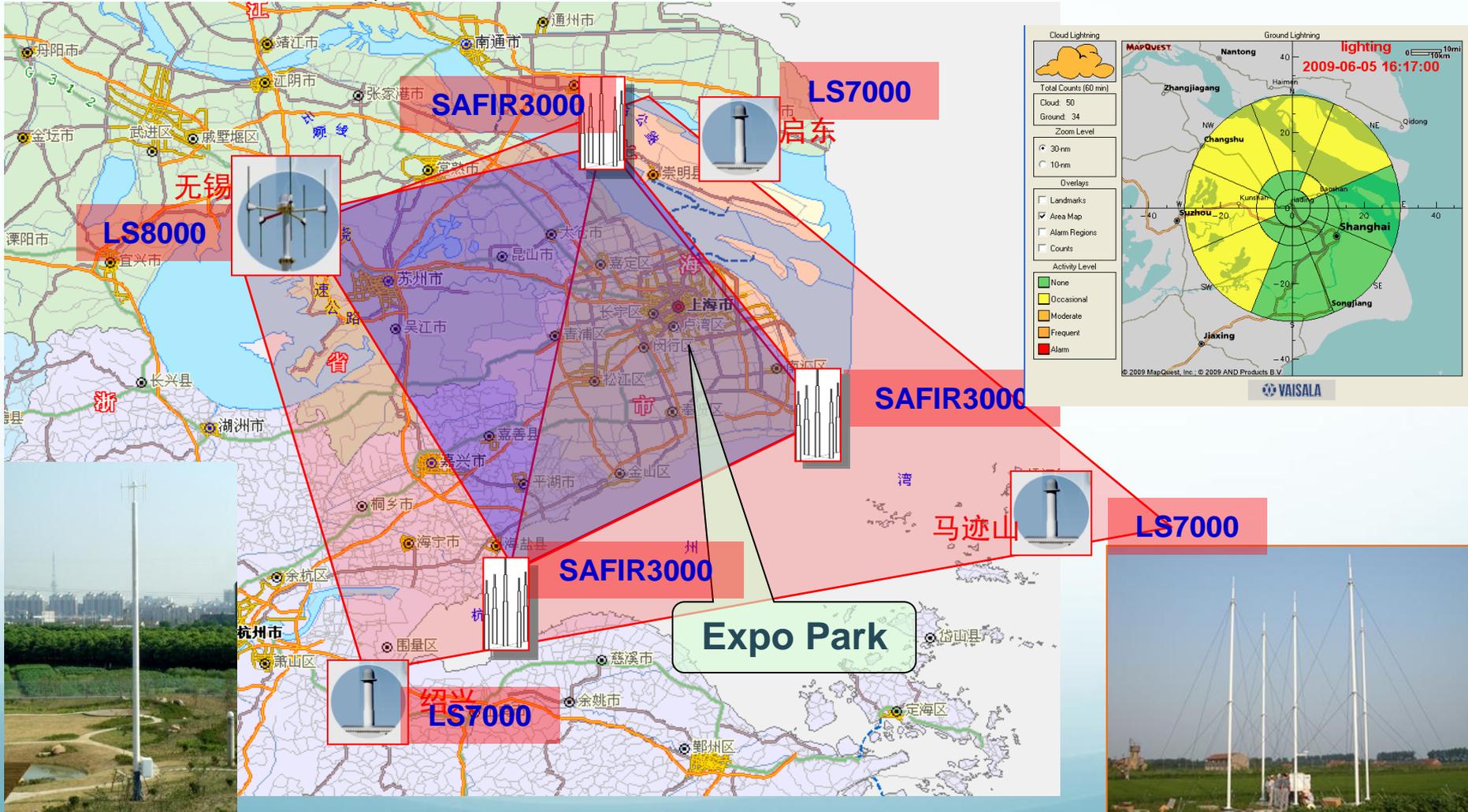
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# The Shanghai Local Total Lightning Detection network

2003-2008 Vaisala 3-station SAFIR 3000

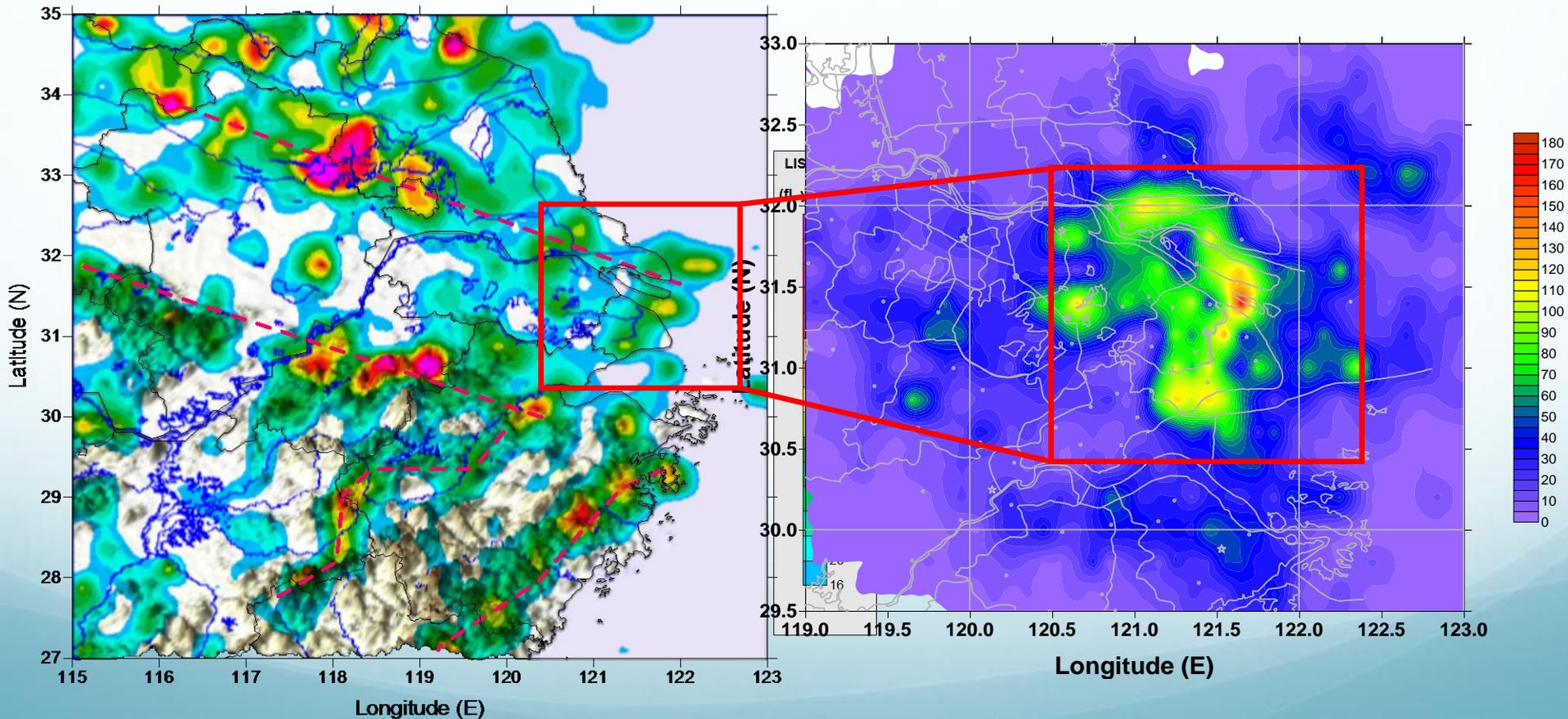
2008: + 1 LS800, 3LS7000



# Lightning observations comparison between TRMM/LIS and SAFIR 3000

TRMM/LIS

SAFIR 3000

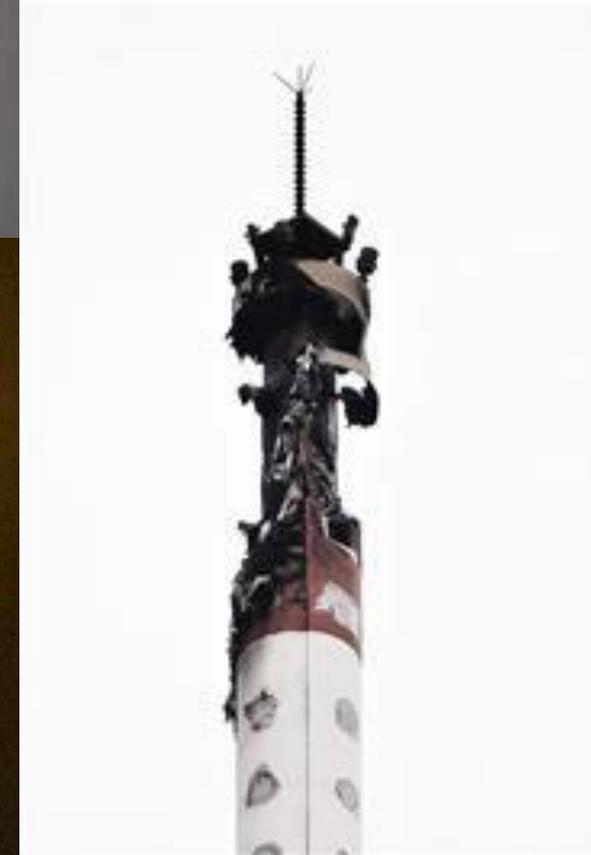


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# Lightning Data Application in Shanghai Operations

- Monitor thunderstorm and lightning activity
- Thunder and lightning disaster investigation and analysis
- Weather forecast - thunderstorm or severe weather nowcasting

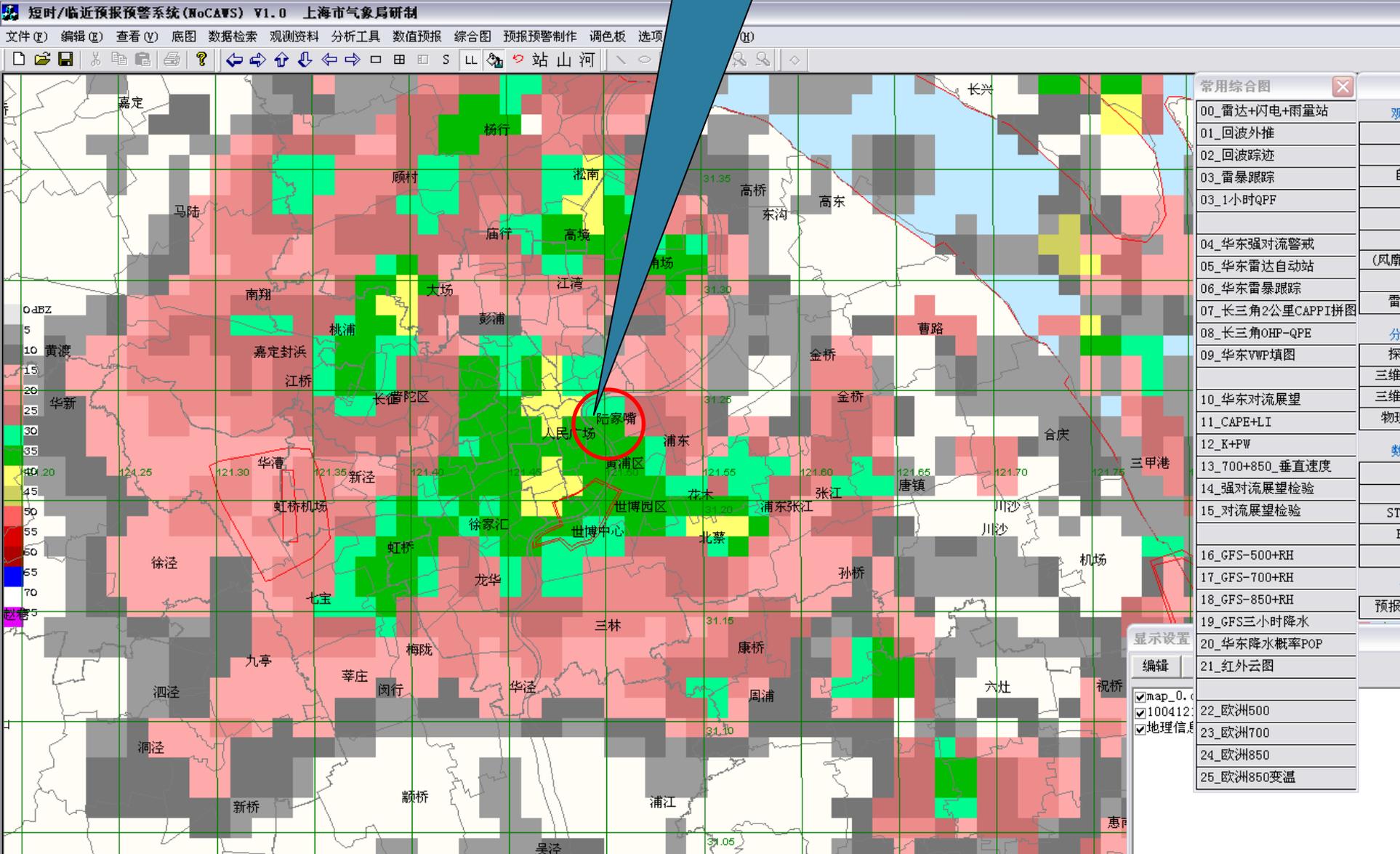
## 2010-03-13 Shanghai East-Pearl TV tower – fire damage caused by a lightning flash in cold season



- However, no lightning flashes within 5km detected by any lightning networks

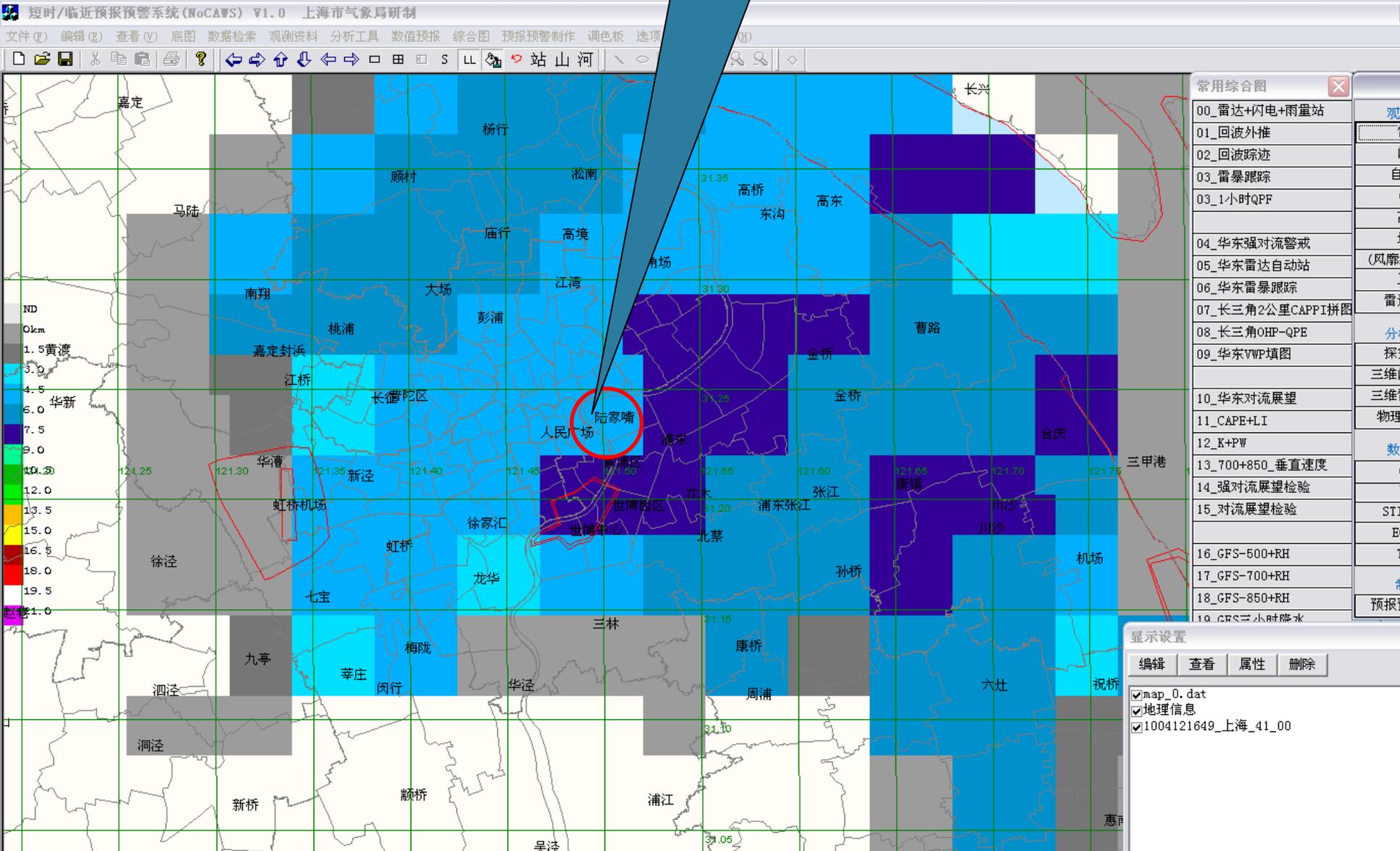
# Ref – WSR88D

TV tower



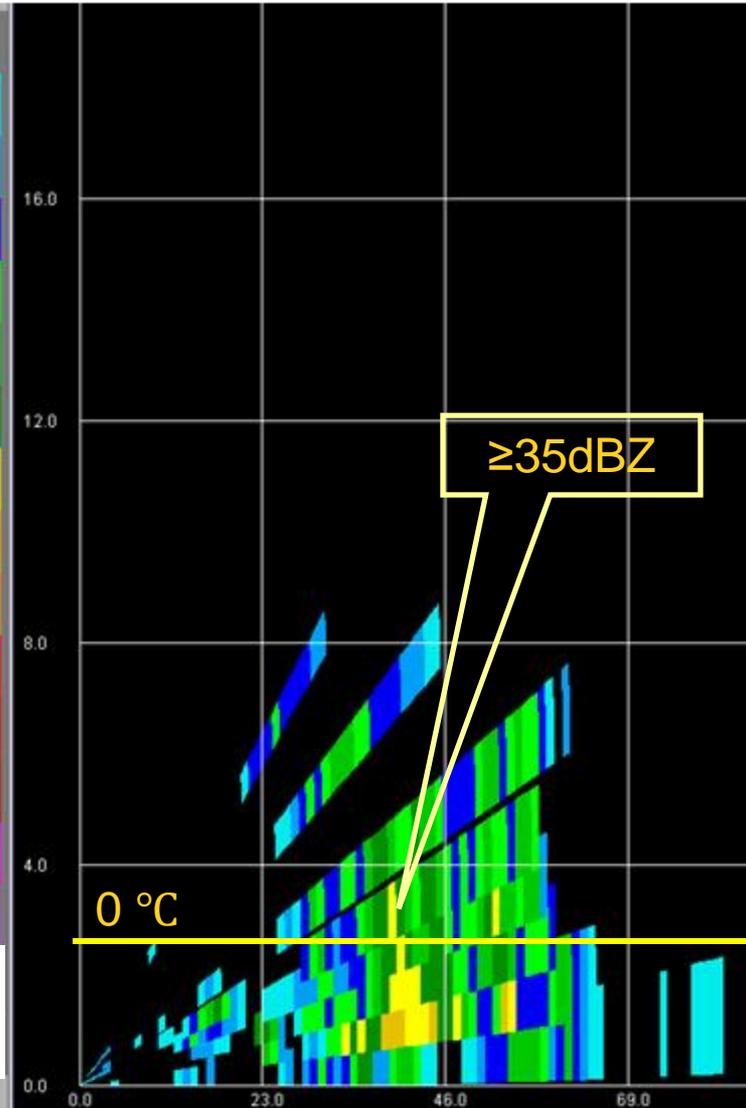
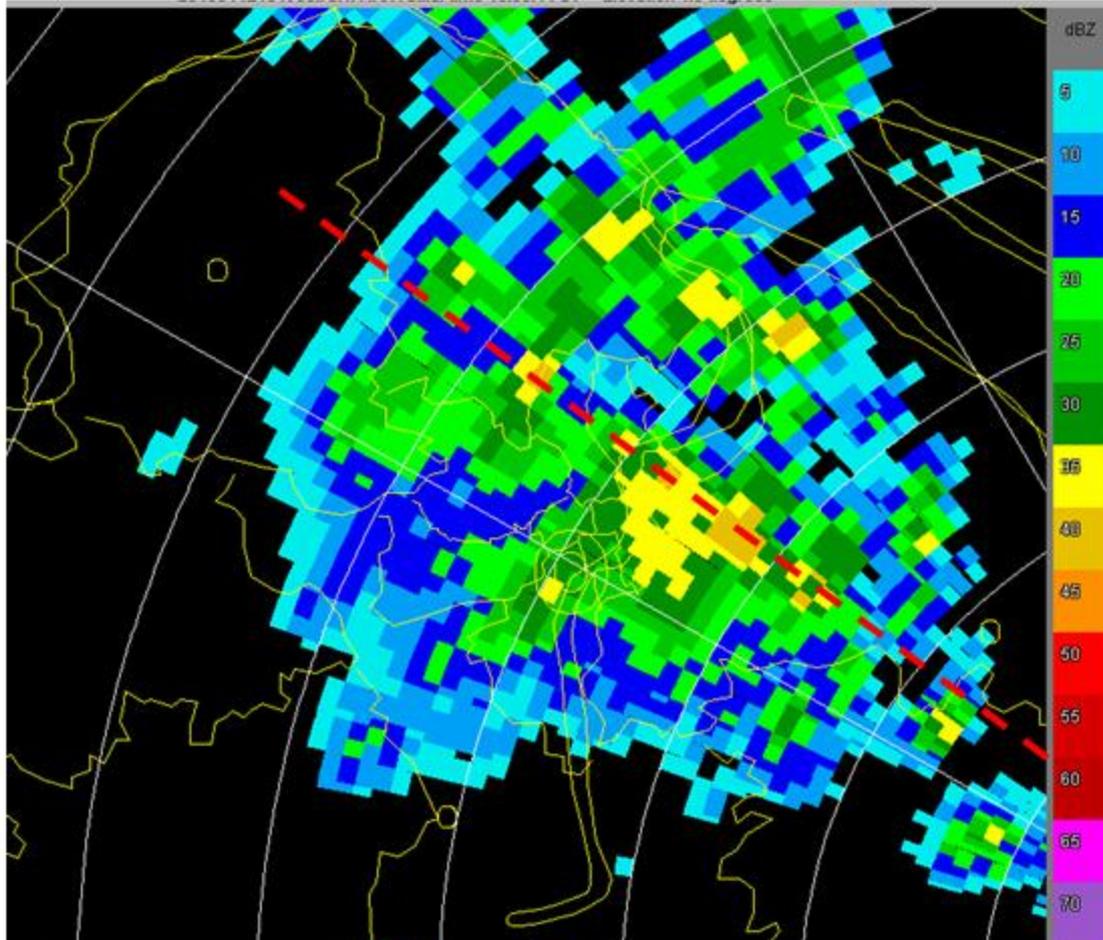
# ET-WSR-88D

东方明珠电视塔



# RCS

Lightning possibility



Why not detected by any lightning localization network?

左键-光标定位; 中键-图像中心定位; 右键-恢复原中心

Cursor from radar: 130.5 30.71 kilometers (Azimut: 130.5 40.2)

# Thunderstorm and severe weather nowcasting

- Two major problems need to be solved
  - Life cycle of thunderstorms
  - Types of thunderstorm
- Lightning data may help us ...

# Structure and lightning activity in a thunder storm life cycle

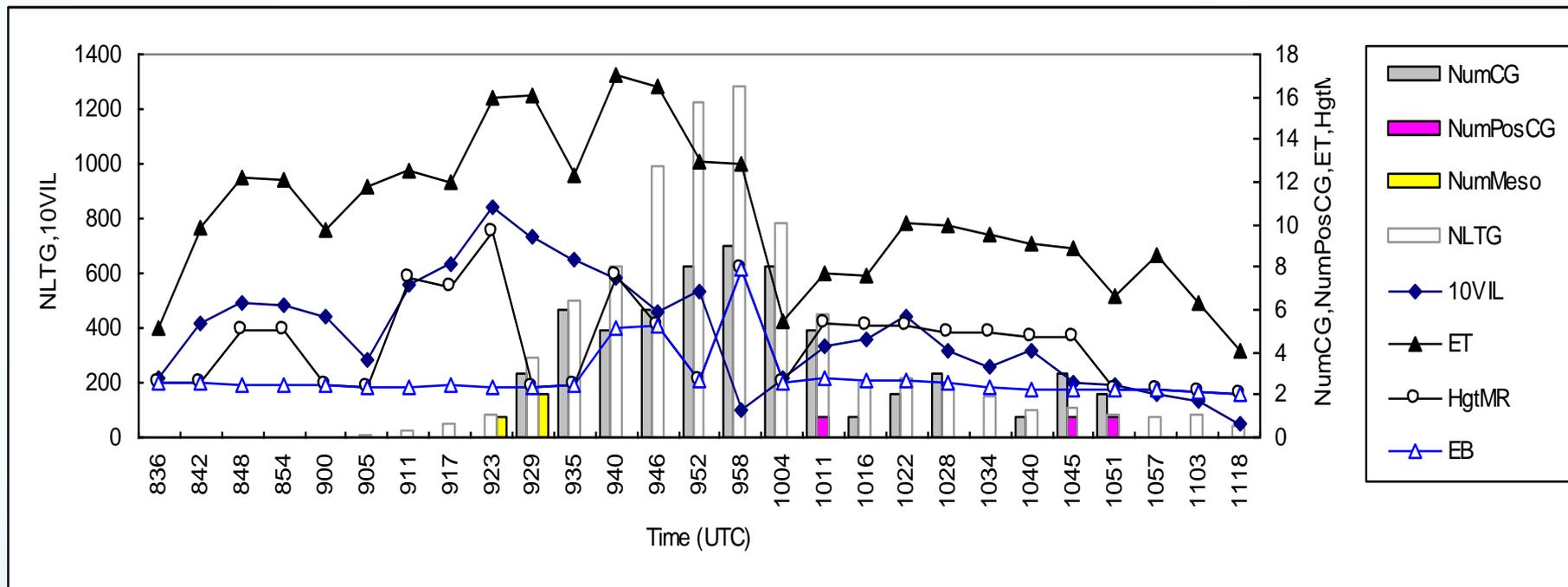
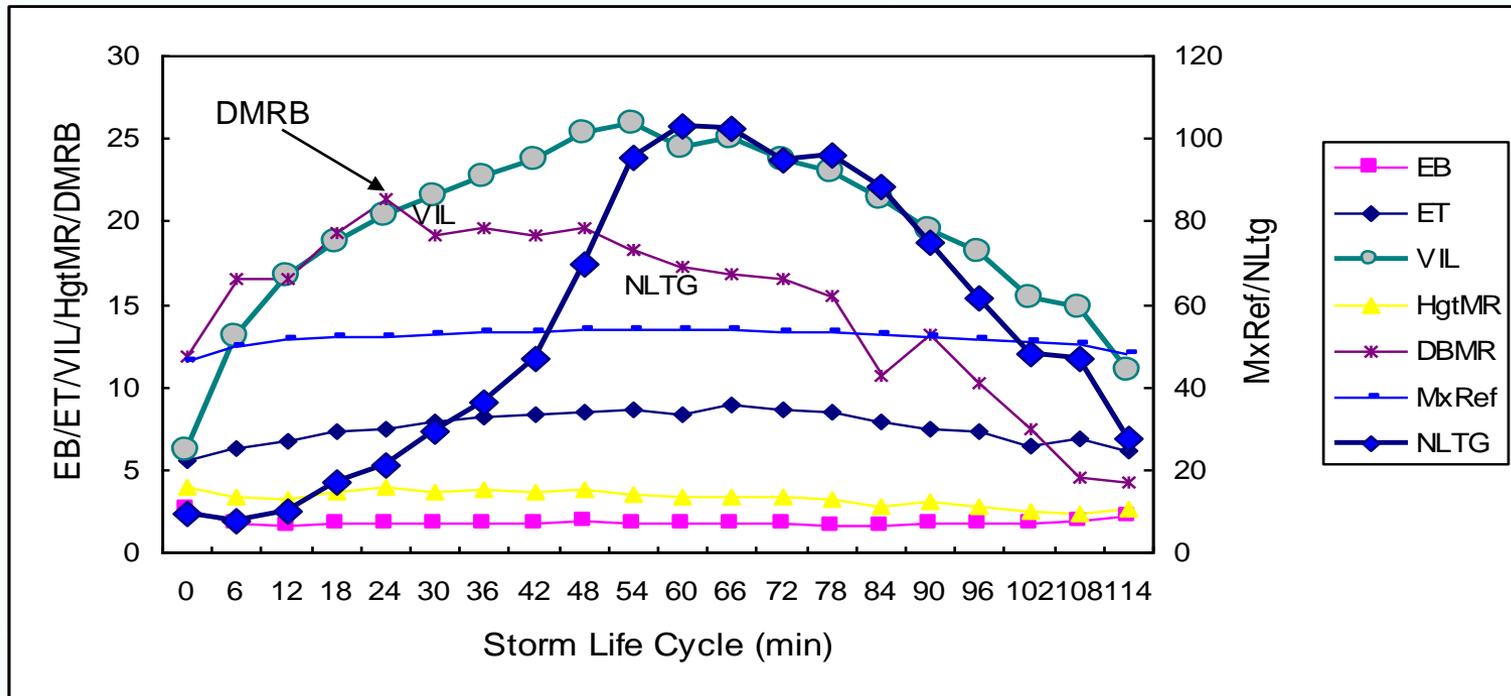


Fig 1. Time series of a thunderstorm's structure information and lightning activity in 6-min intervals from 08:36 UTC to 11:18 UTC on June 24, 2006. White histograms stand for counts of total lightning flashes. Gray and purple histograms stand for number of all CG and positive CG lightning flashes. Yellow histograms stand for number of mesocyclones (M). Curves with white (black) circles stand for height of maximum reflectivity - HgtMR (vertically integrated liquid-VIL), curves with black triangles for echo top - ET, curves with blue triangles for echo base 0 EB.

# Averaged-life cycle of 120-min storms – should be in ST2009



## DMRB – height Difference between Max-Reflectivity and echo Base:

a high value in initiation stage; maximum before VIL and ET; flat in the mature stage; declines as storm decays; lowest in dissipating stage.

## A nowcasting scheme for STM life cycle :

after DMRB has not increased for 2-4 scans (12-24 minutes) or it is decreasing gradually, and NLTG has a sudden jump, it can be a signal that the storm has been in its mature stage and is going to decay soon.

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# Overview of World Expo 2010 Shanghai, China

**Theme:** Better City, Better Life

**Duration:** May 1st to Oct. 31st 2010 (184 days)

**Location:** Both sides of the Huangpu River, downtown Shanghai.

**Participants:** 246 countries, regions and international organizations.

**Visitors:** 70million





**World  
Meteorological  
Organization**

## **Goals of WMO/CMA Participation in Expo**



**China  
Meteorological  
Administration**

An excellent example of how Meteorological and Hydrological Services can participate in international events in more than just a service capacity.

The World EXPO presents a unique and exciting opportunity to reach out to the general public on a global level.

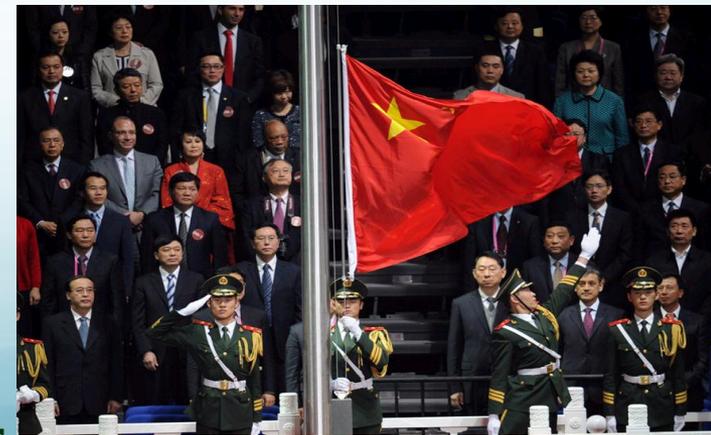
Highlight improvements in DRR (Disaster Risk Reduction). for natural disasters as well climate change adaptation strategies.

Increase public awareness of Meteorological Sciences and Services.

***“Better city, Better Life, Better Weather Service”***

# Challenges for the EXPO Weather Service

- a) **Duration and high impact weather:** May 1<sup>st</sup> to October 31<sup>st</sup> 2010, 184 days, covering Shanghai's entire rainy season.
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- e) **Numerous Events and Performances:** Besides the opening and closing ceremonies, there will be about 20,000 events and performances.
- f) **Large Amount Temporary Buildings:** More than 70% structures in the Expo Park are temporary construction, and are vulnerable to natural hazards.



# MeteoWorld Paviloin



WMO and CMA joint participat

Southern Thunder 2011 (ST11) Workshop, Norman, OK, USA. 11 – 14 July 2011



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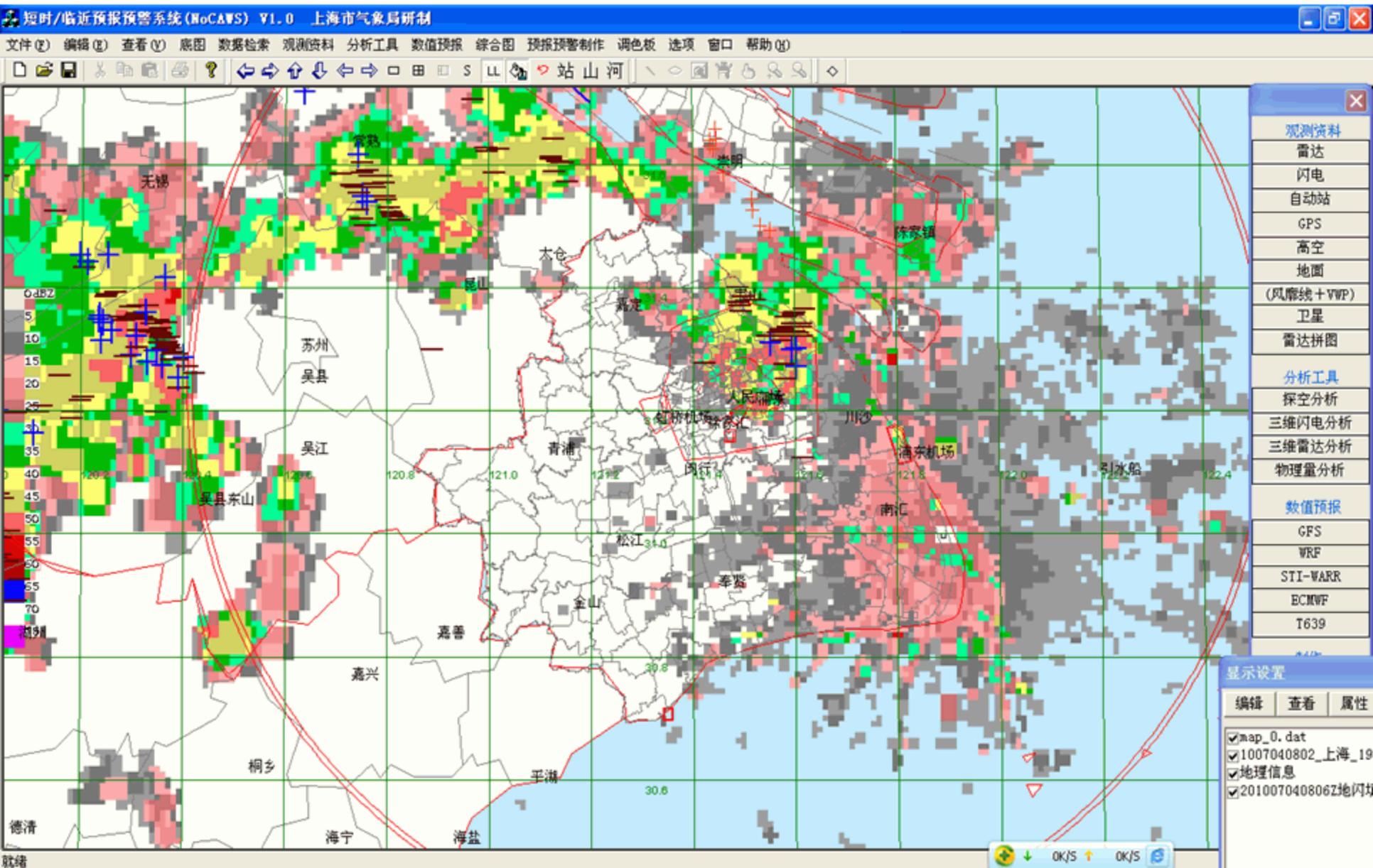
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# 3. Cases

- **Case 1: Jul. 4, 2010. A squall line**
- **Case 2: Aug. 25, 2010. A local severe thunderstorm**
- **Case 3: Sep. 1, 2010. A tropical cyclone related heavy rain.**



2010-07-04 08:00 UTC 0.5 Ref + lightning flashes (blue "+": positive CG, brown "-": negative CG, small orange "+": IC)

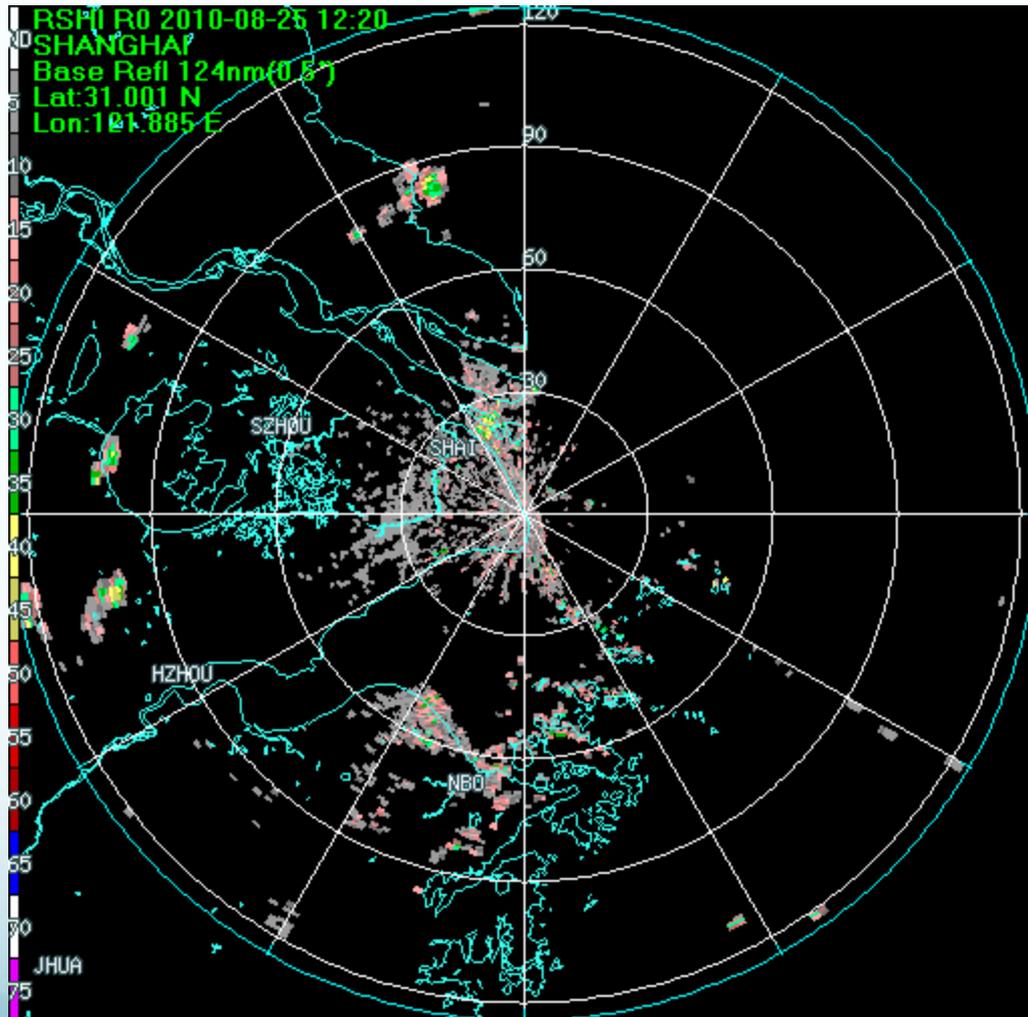


# The WMO-CMA Mete-Pavilion

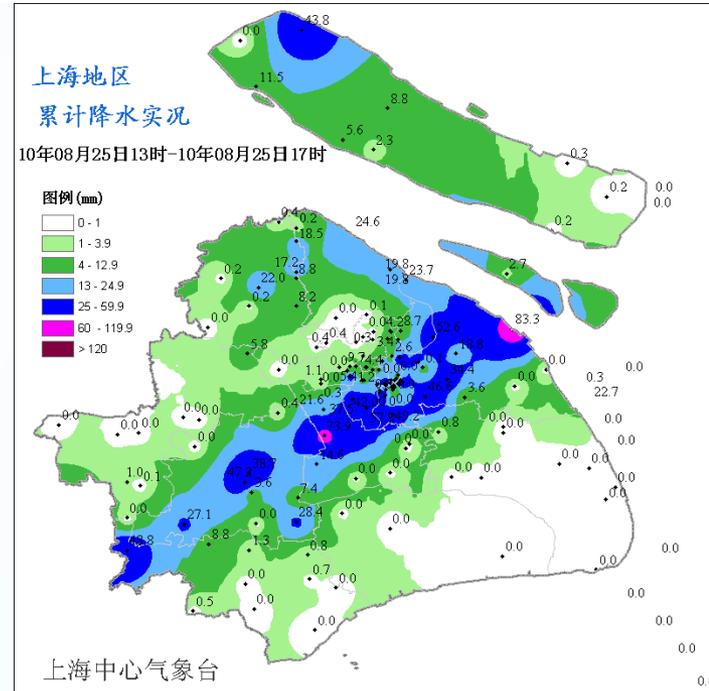


# 2010-08-25 a local hail storm

## Case 2: Aug. 25, 2010.



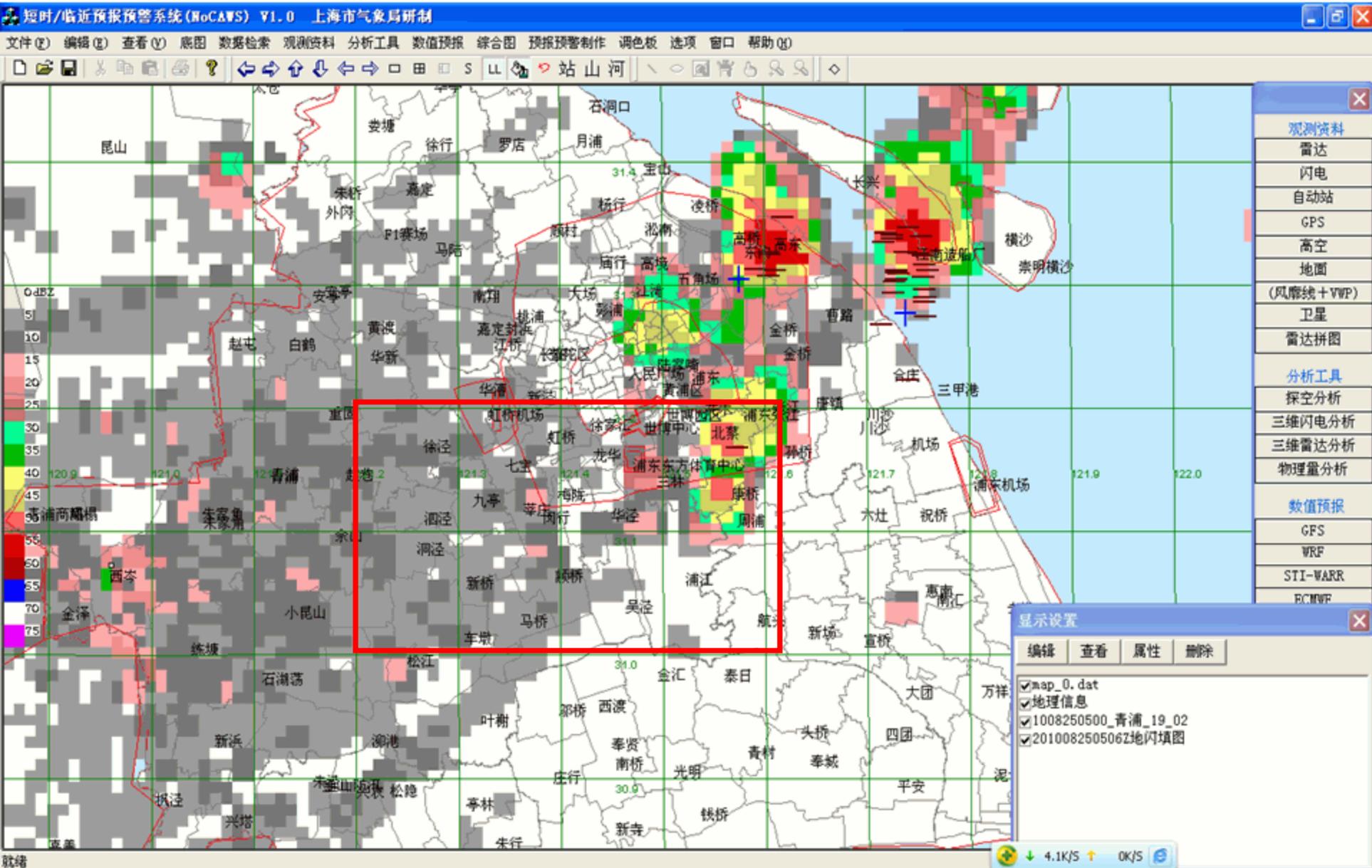
Ref 12:20-16:04 (LST)



2010-08-25 73.1mm/3hr  
0.9cm hail



2010-08-25 05:00 UTC 1.5 Ref + lightning flashes (blue "+": positive CG, brown "-": negative CG, small orange "+": IC)

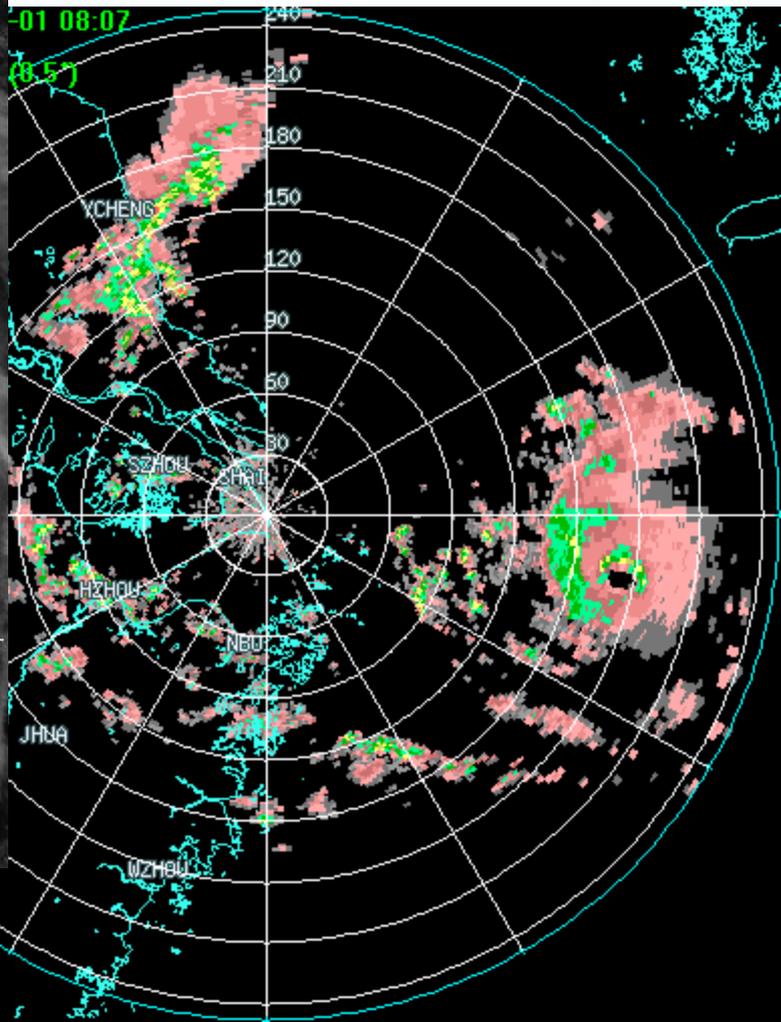
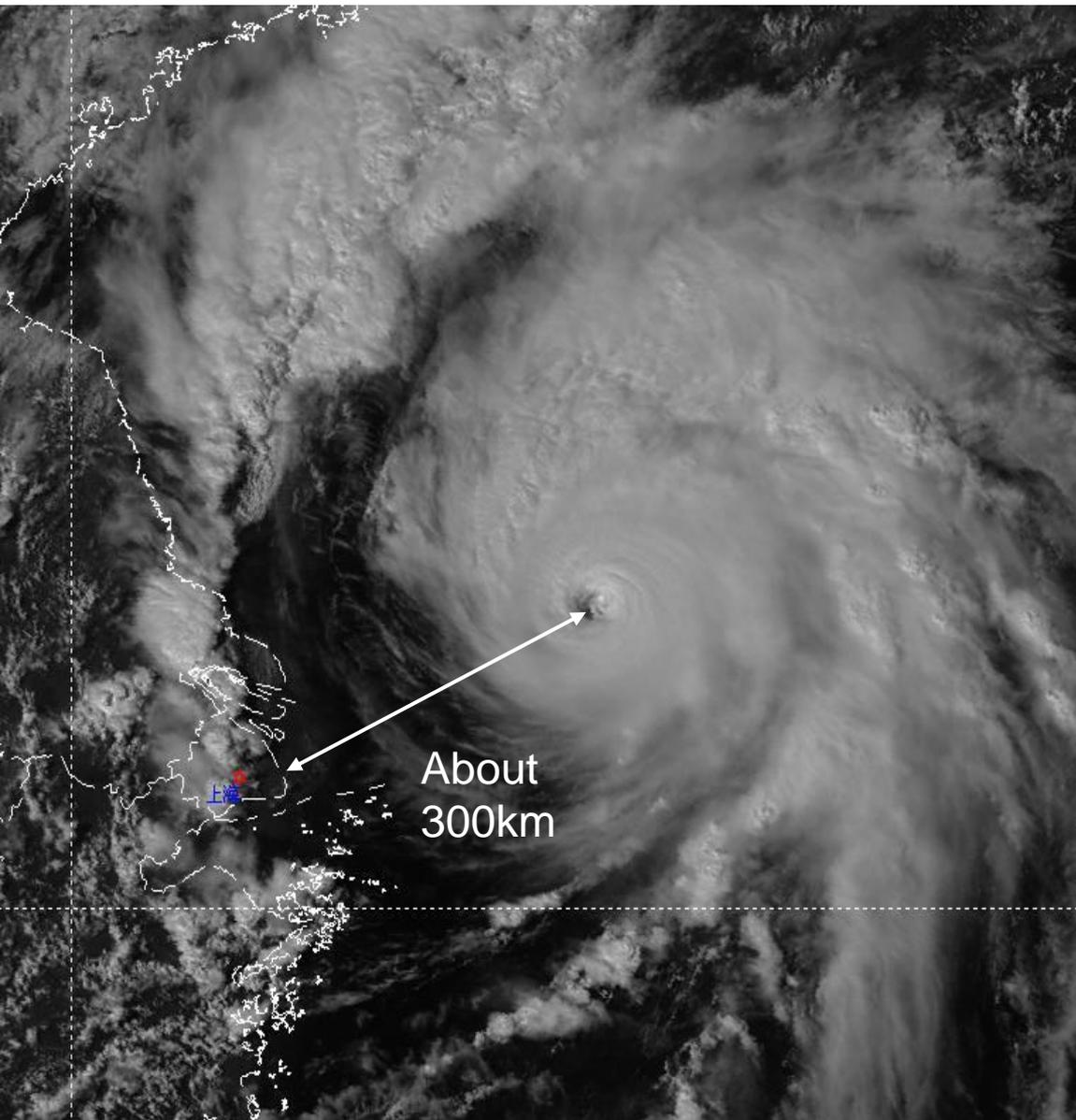


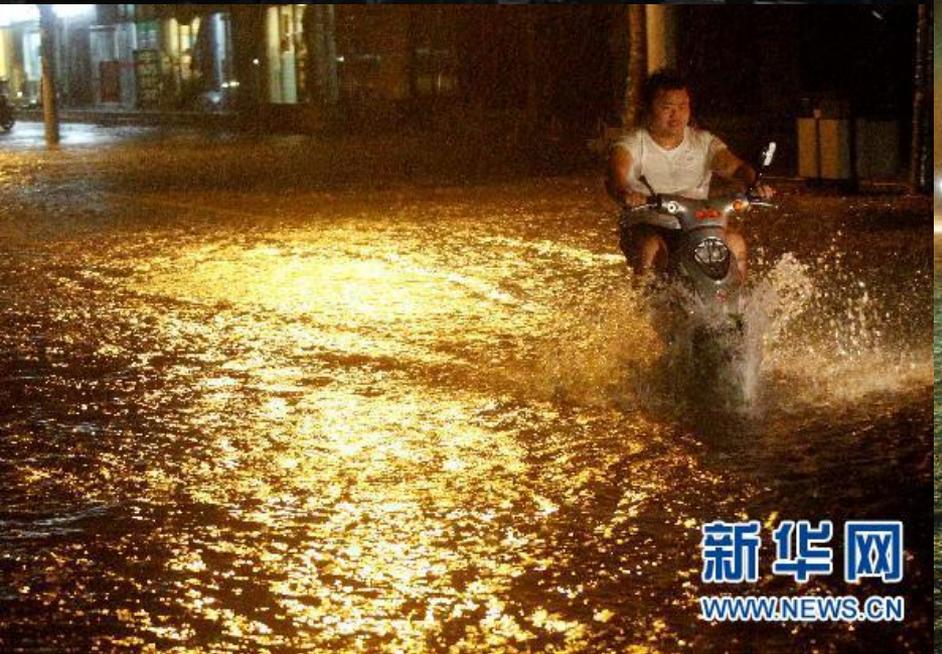


# Case 3: Sep. 1, 2010.

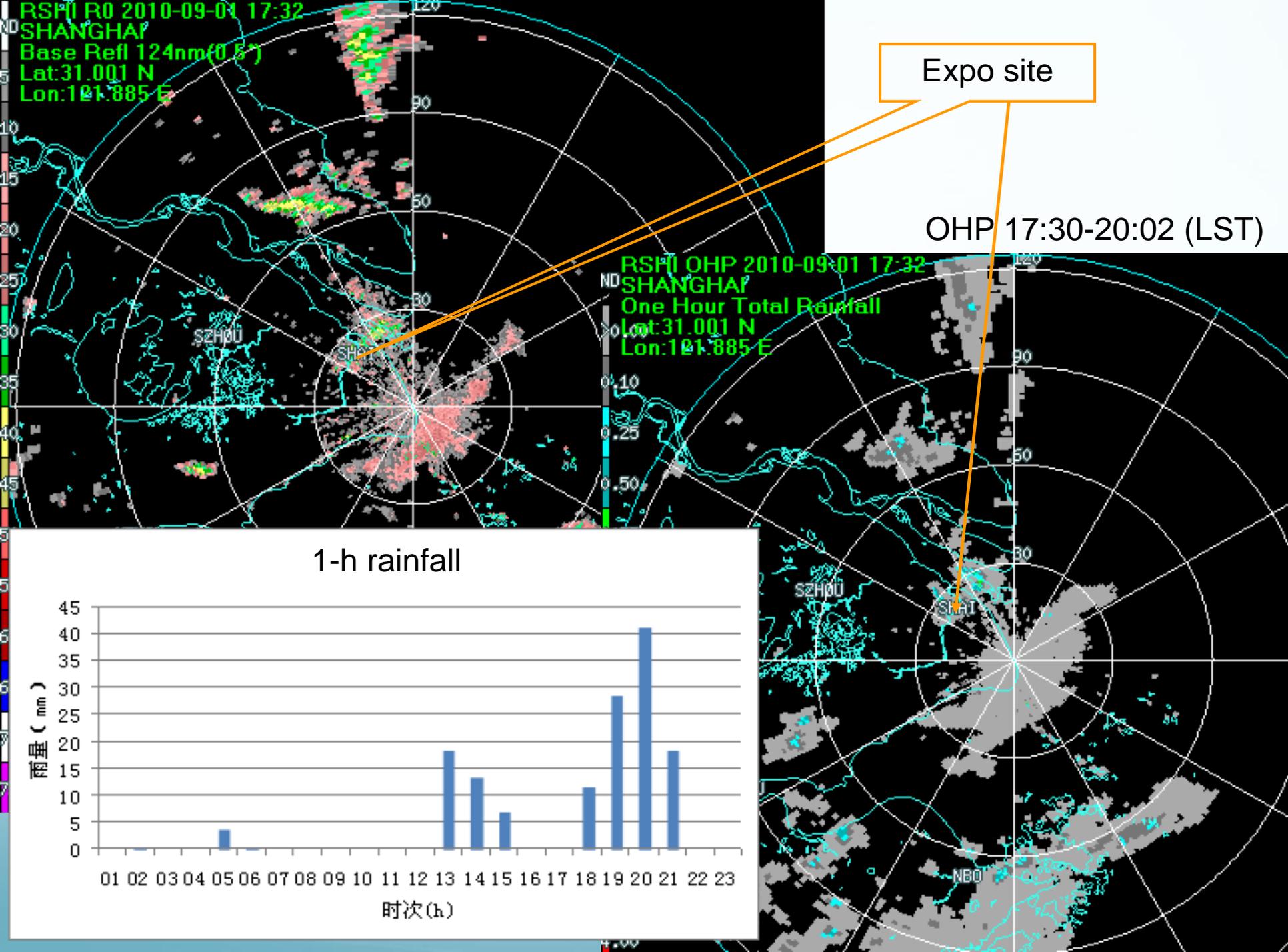


# Visible satellite image and radar reflectivity loop

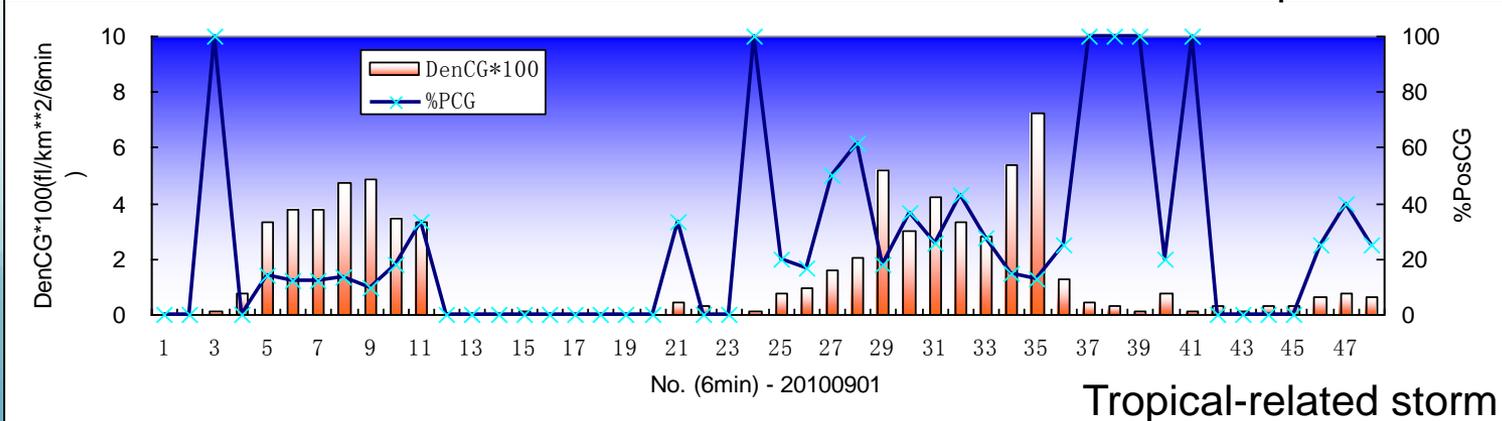
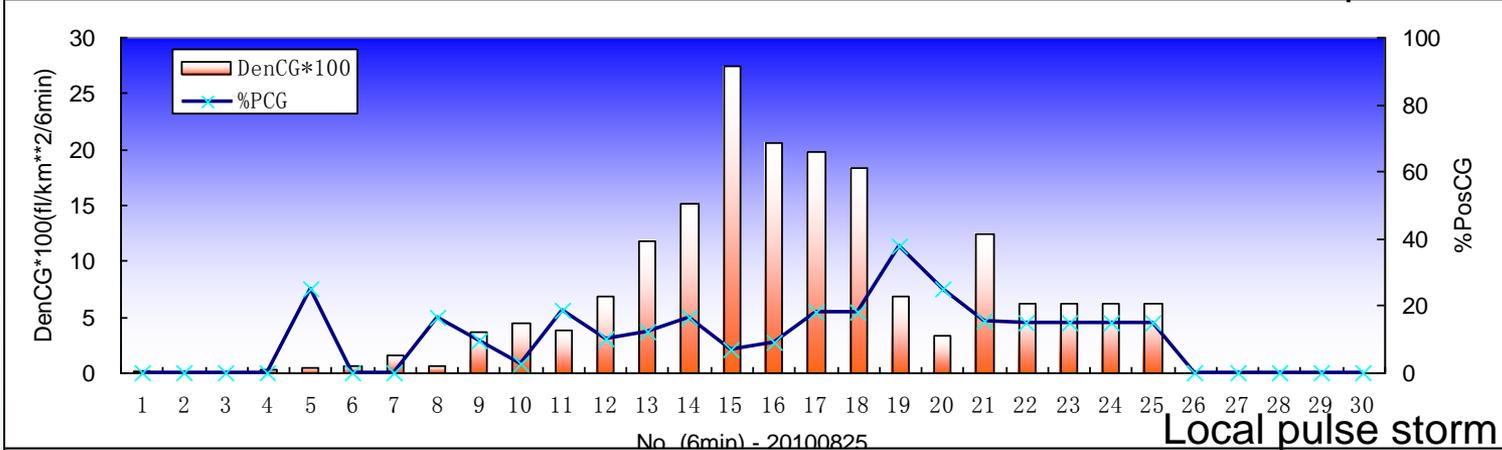
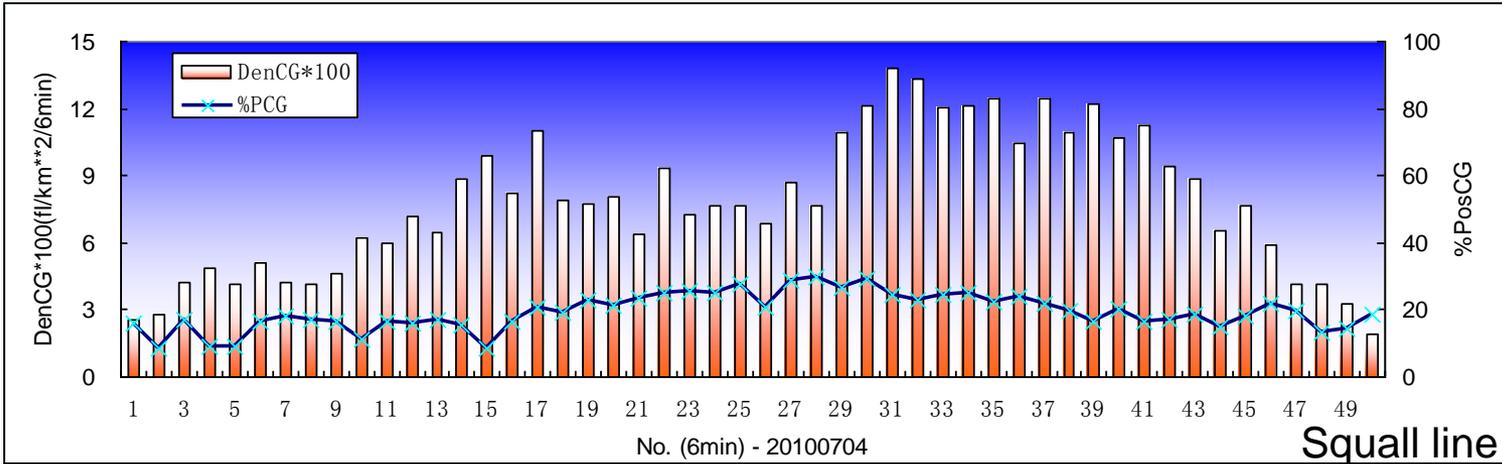




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# Lightning density (fl/km<sup>2</sup>/6min) + % of Positive CG in storms



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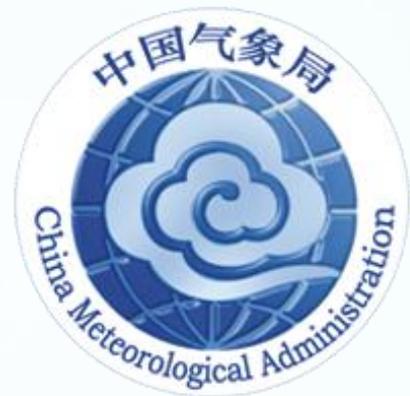
# 4. Summary

- Total lightning data
  - lightning activity monitor
  - evaluate thunderstorm life cyclone with other data
  - help to identification type of thunderstorms
- Type of thunderstorms – different lightning characteristics
  - MCS: high lightning density, low %PosCG
  - Local pulse storm: very high lightning density, low %PosCG
  - Tropical-related storm: low lightning density, high %PosCG

Thanks!  
Any questions?



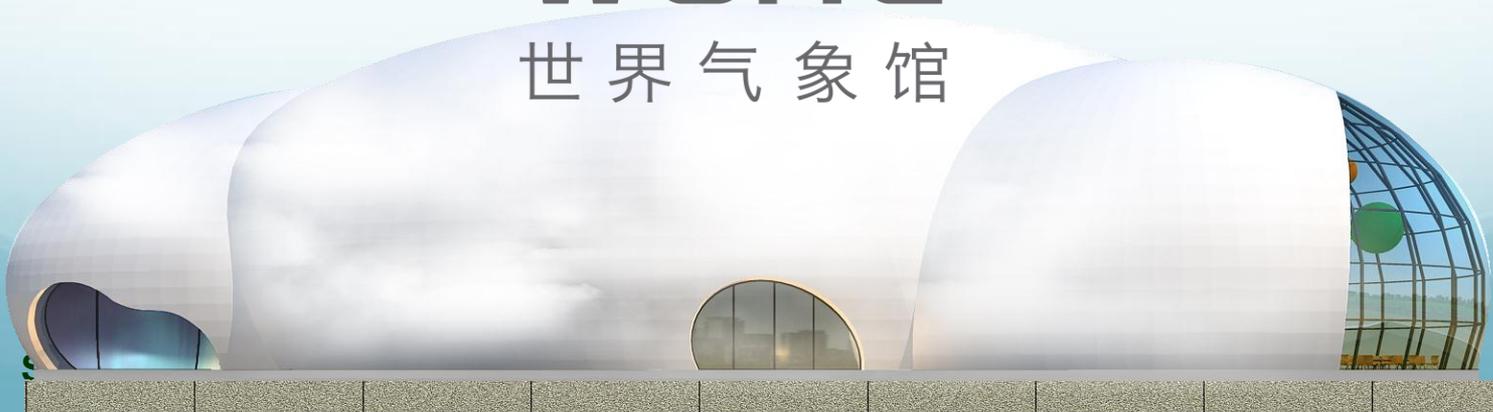
**World  
Meteorological  
Organization**



**China  
Meteorological  
Administration**

**Meteo  
World**

世界气象馆



# Overview of World Expo 2010 Shanghai, China

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The opening ceremony of Expo 2010, Shanghai was held along the banks of the Huangpu River on the evening of April 30<sup>th</sup> 2010.



# A Hot Spot for visitors all over the World



**Saudi Arabia**



**Russia**



**Australia**



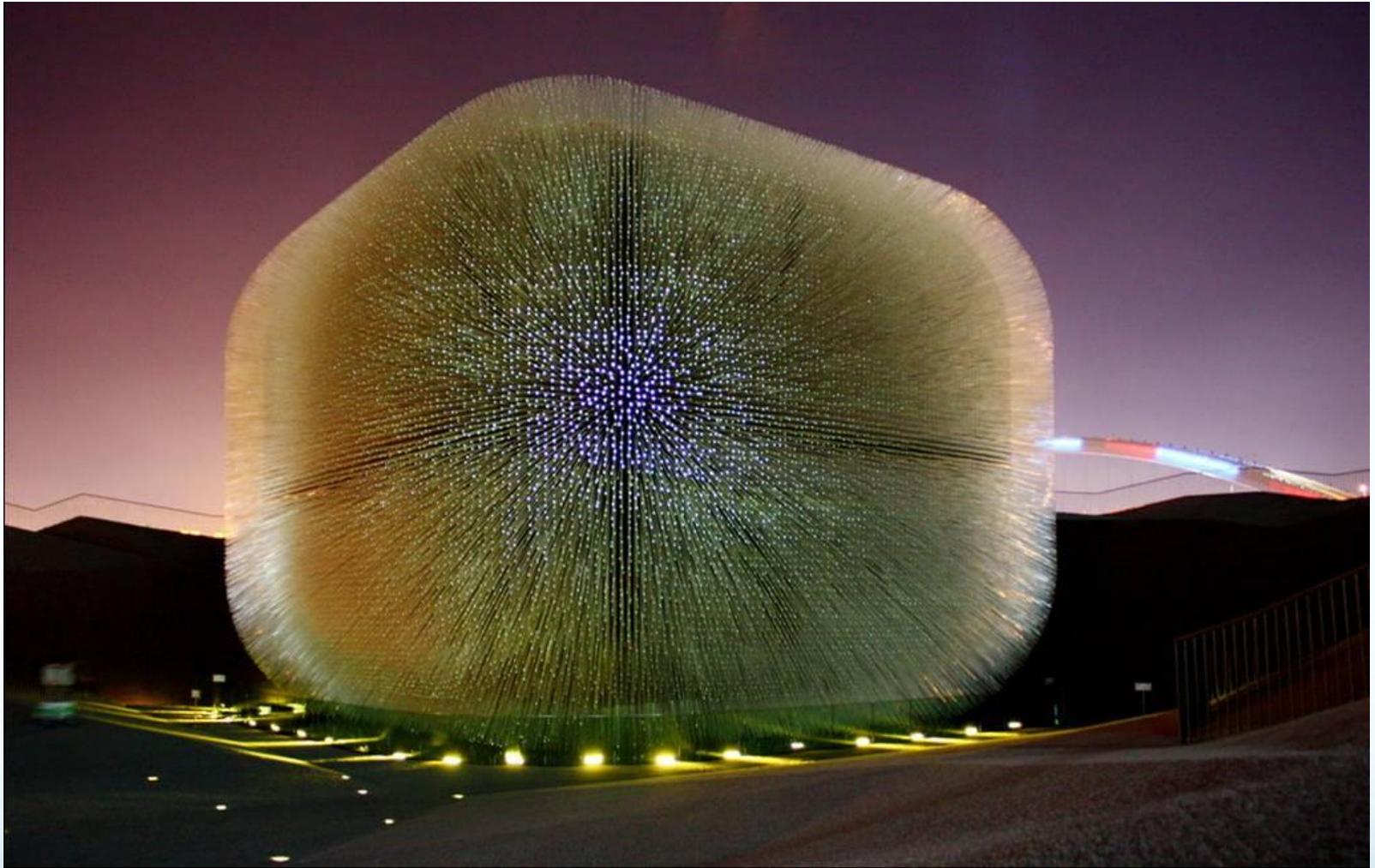
**Malaysia**



**South Africa**



**Brazil**



# UK Pavilion

a dazzling cube

Southern Thunder 2011 (ST11) Workshop, Norman, OK, USA. 11 – 14 July 2011



**World  
Meteorological  
Organization**

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WMO and CMA joint participat

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# A pavilion for all the world's meteorologists



Under grey skies on a drizzly Sunday afternoon, an international group of weather presenters put on a show and brought a little sunshine to the celebration.

**Southern Thunder 2011 (ST11) Workshop, Norman, OK, USA. 11 – 14 July 2011**

UN Secretary General, Pan Ki-Moon  
Visited Meteoworld Pavilion



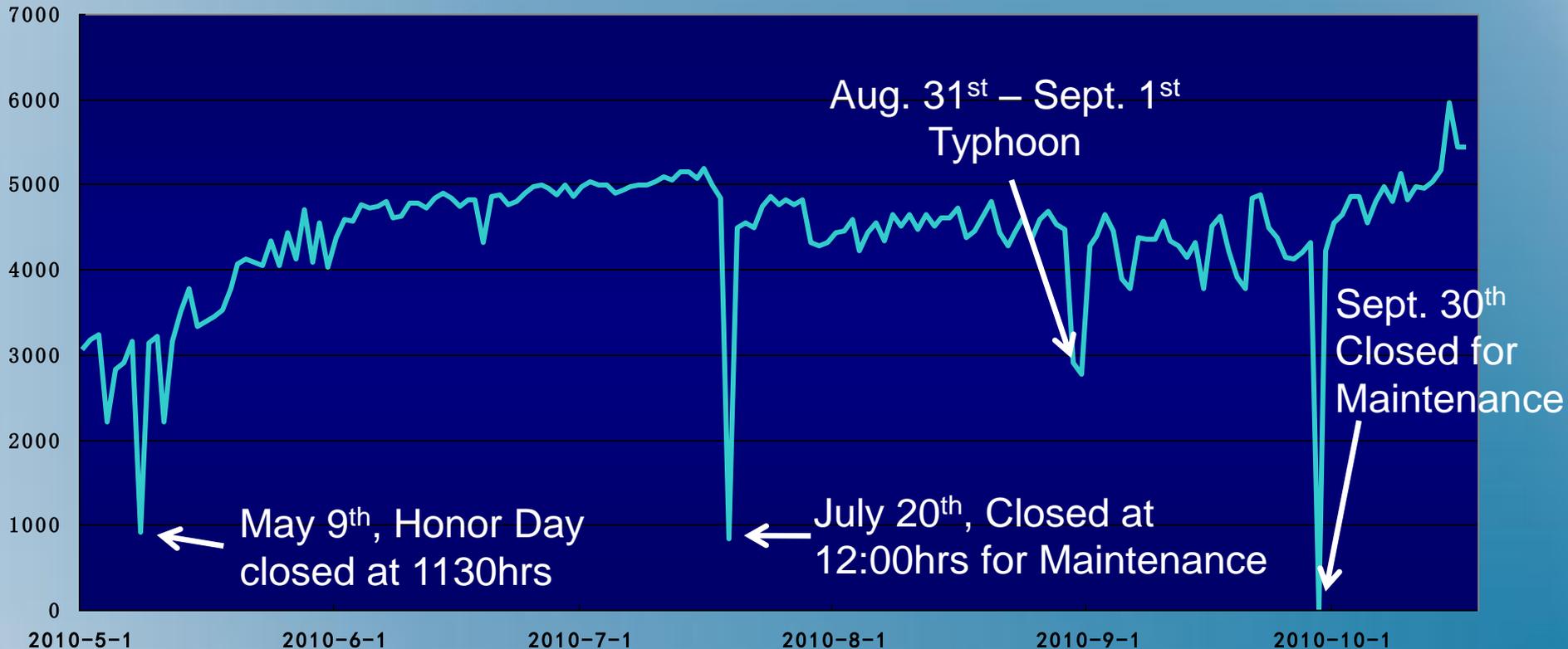
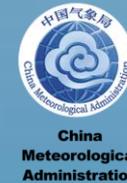
“I am very much impressed by the most creative way of forecasting weather. This is the way we can work together to address the climate change. I commend the work of WMO in working together in fighting the climate change.”

**Southern Thunder 2011 (ST11) Workshop, Norman, OK, USA. 11 – 14 July 2011**

# 762,417 visitors and counting...

## MeteoWorld Attendance

May 1<sup>st</sup> to Oct 19<sup>th</sup>, 2010



# Theme activities

A series of workshops sponsored by the CMA and WMO were held at the pavilion. These theme activities focused on important issues and challenges affecting the Met services and attracted much attention.

20 June, Renewable Energies, Better Cities

17 July, City Life and Meteorological Risks

8 August, “Eyes” on Global Weather

16 September, Meteorological Service for Your Splendid Life

13 October, Weather Forecasts Take Care of You Every Day



# The response from VIPs



“As the only independent international organization at the Shanghai World Expo, MeteoWorld must be warmly welcomed and appreciated by the public for its novel, unique and creative design, which is to protect people and to improve their quality of life as well as incoming natural disasters.”

- Alexander Be, Secretary General WMO

# The response from students



Southern Thunder 2011 (ST11) Workshop, Norman, OK, USA. 11 – 14 July 2011

# Media Response



## Expo Post



**Expo promotion on October 2009 --- one of the most striking pavilions**

- Listed as an optimal choice for a day trip to Expo Park by CCTV News.
- Regarded as one of the most popular pavilions by Expo Bureau.
- 150 interviews by domestic and foreign media.
- Google search results : 2.56 million hits from May 1<sup>st</sup> to June 5<sup>th</sup>.

# EXPO Weather Observatory and Studio



# Challenges for the Expo Weather Service

The Shanghai  
Weather Service



**Duration**

**Location**

**Population**

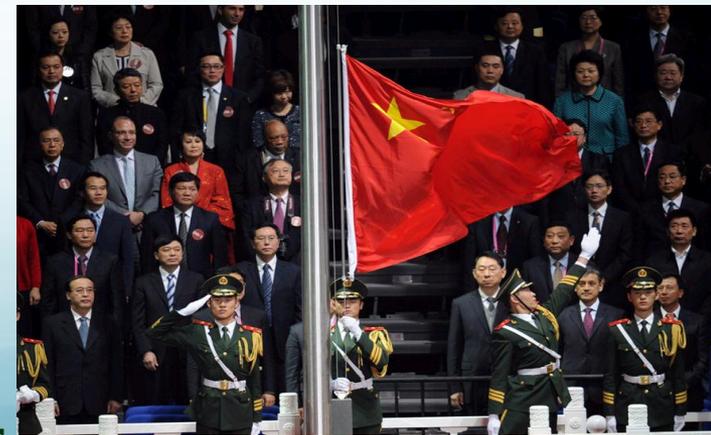
**Events**

**Temporary Buildings**



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# Challenge accepted!

We focused on providing refined weather forecasts and impact forecast products for Expo command and Expo participants.

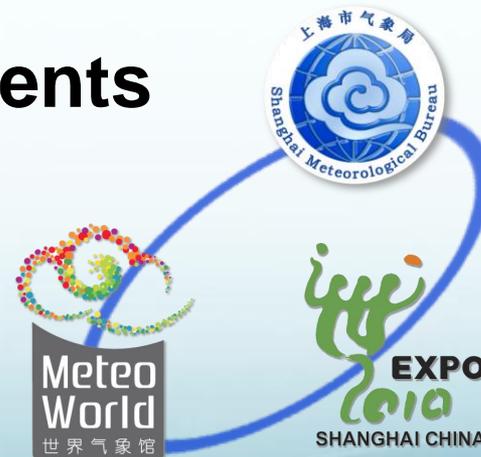
A new system was set up to provide both weather and impact forecasts for all time ranges, with a short-term nowcasting subsystem as the core.

In the system, special attention was given to the following three areas:

**High impact weather events**

**Sensitive locations**

**High sensitive users**



# Customized service and support

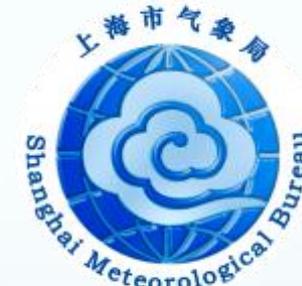


The Shanghai  
Weather Service

The **Expo Observatory at MeteoWorld** provides on the spot weather service to the **Expo Site**.



The **Public Weather Service and Weather Forecast Platforms at the SMB** act as the backstage “factory” providing technical and personnel support to the Expo Weather Service.



Expo Weather  
Observatory and Studio



Expo Operation &  
Coordination Center



Public Weather  
Service Centre



Weather Forecast  
Centre

# Expo Park Observation Network



The Shanghai  
Weather Service

AWS (26)

Atmospheric component

Monitoring station (1)

Wind profiler (1)

Integrated Weather

Observation Station (1)

## Special equipment

- LIDAR
- Laser ceilometers
- Eddy flux stations
- Microwave radiometer
- Sun photometer
- Atmospheric electric field mill
- Sky viewer
- Raindrop detector



# Integrated Weather Observation Station



The Expo Integrated Weather Observation Station is also an exhibit at Expo 2010. 900 m<sup>2</sup> of Meteorological Technology on display for the public.

# Signal Tower (165m)

A repurposed old smokestack at the Expo Site is now the world's tallest Meteorological signal tower.



## Weather Indicators

White: Fair weather

Purple: Bad weather

## Disaster Warning Signals

Blue: Common

Yellow: Relatively serious

Orange: Serious

Red: Very Serious

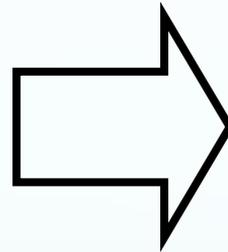
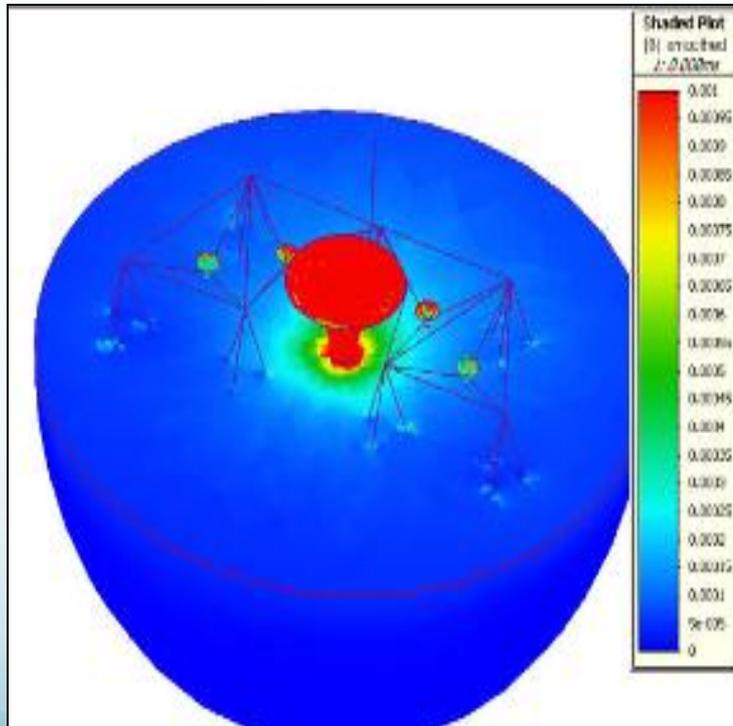


# Special Working Plans for Expo 2010

## Risk mapping

Climate analysis report drafted: “Refined Analysis of Climate Data for Expo2010”

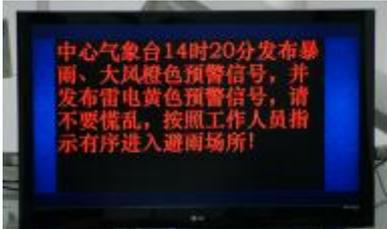
“Main Disastrous Weather Risk Assessment Report” includes multi-agency cooperation and coordination suggestions.



**Distribution of Electromagnetic field at Sun Valley (Expo building) when struck by lightning**

**Yellow Flag for Lightning Risk**

# Organization of Expo Weather Service



Display Screens(214)



Expo Weather Service Center

Forecast Platform

Public Service Platform

Early Briefing, Early Warning

Feedback and analysis



Landscape tower for weather warning



Expo Observatory

Posts at Expo Command

Posts at Meteoworld

Warning information for heat stroke, UV, Bacterial hazards etc.

Hotline, Telephone Websites, SMS, etc.

Coordination mechanisms with participants: services delivered via email, website, hotline or face to face



Management Sectors

Standard Multi-agency joint action with Expo Command Center, according to the 'Emergency Response Preparedness Plan for Expo'



Visitors

Participants

