WMO/WWRP 4th International Symposium on Nowcasting and Very-short-range Forecast (WSN16)

Research on Lightning Nowcasting and Warning System and Its Application

Wen Yao

Chinese Academy of Meteorological Sciences Beijing, China

yaowen@camscma.cn

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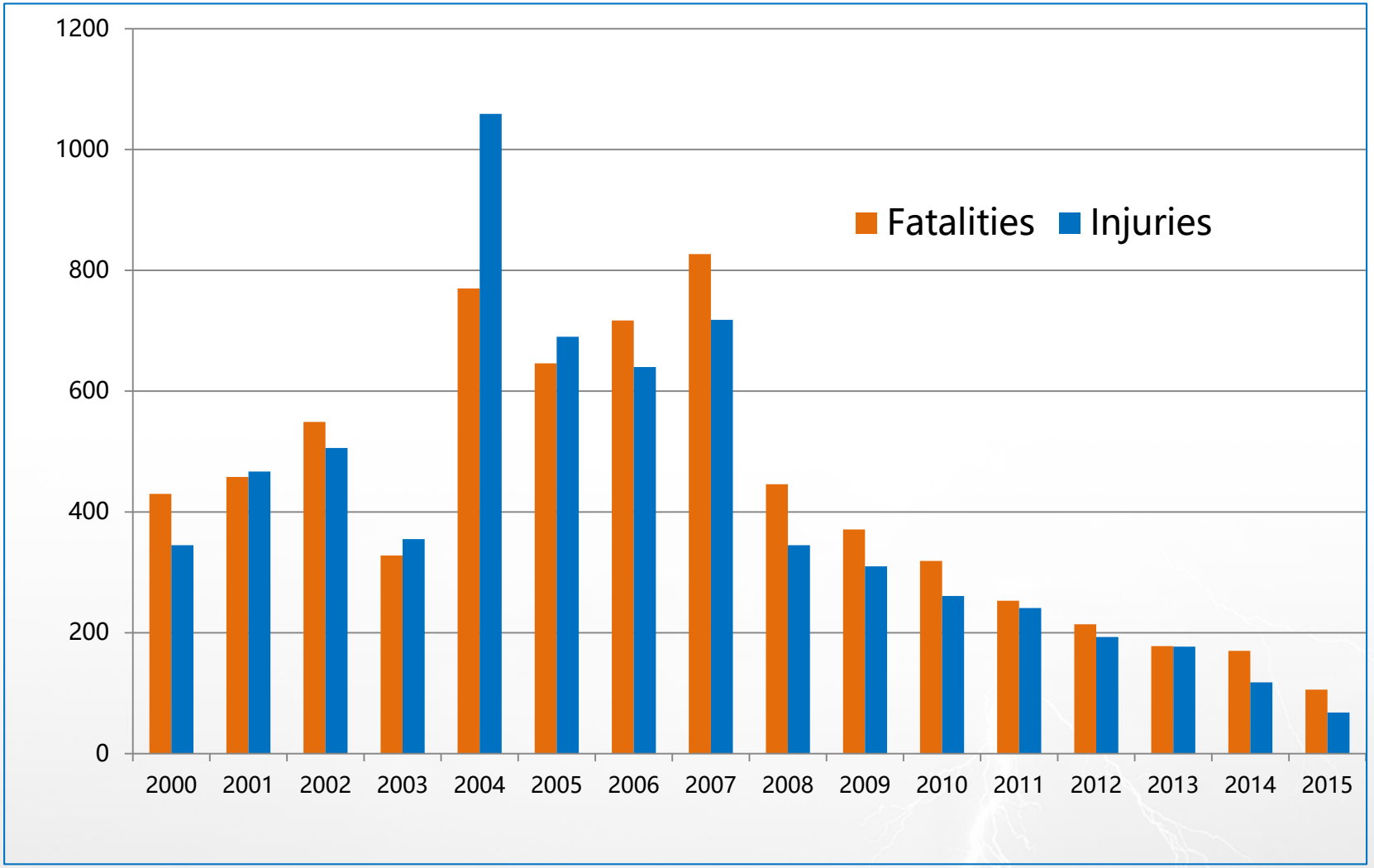
Lightning hazards

Lightning hazards



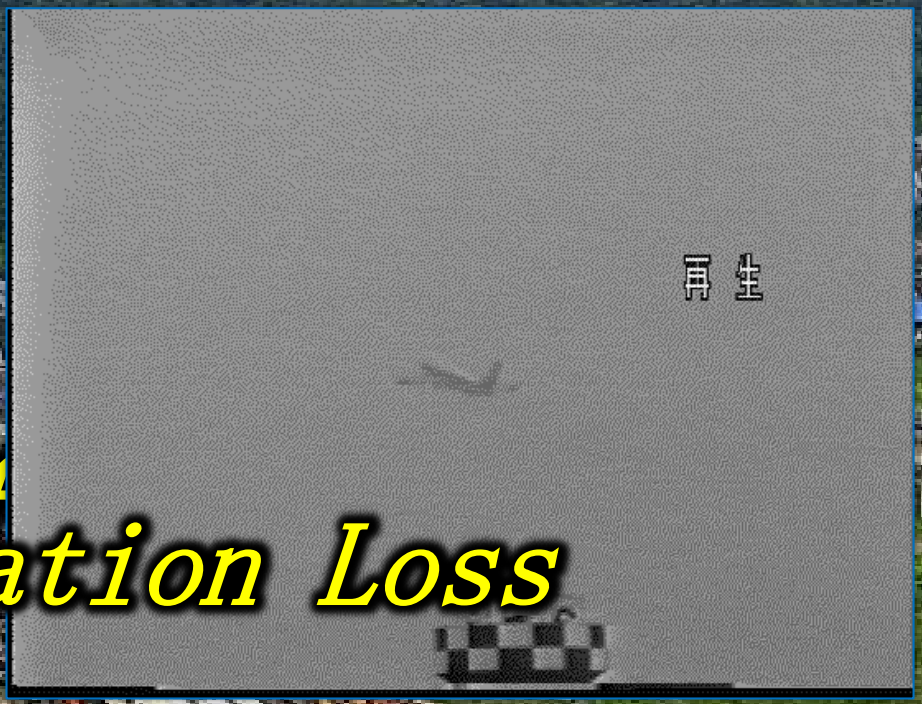
About 1000 people, on average, have been dead or injured by lightning strikes every year in China.


Lightning-attributed
Forest fire

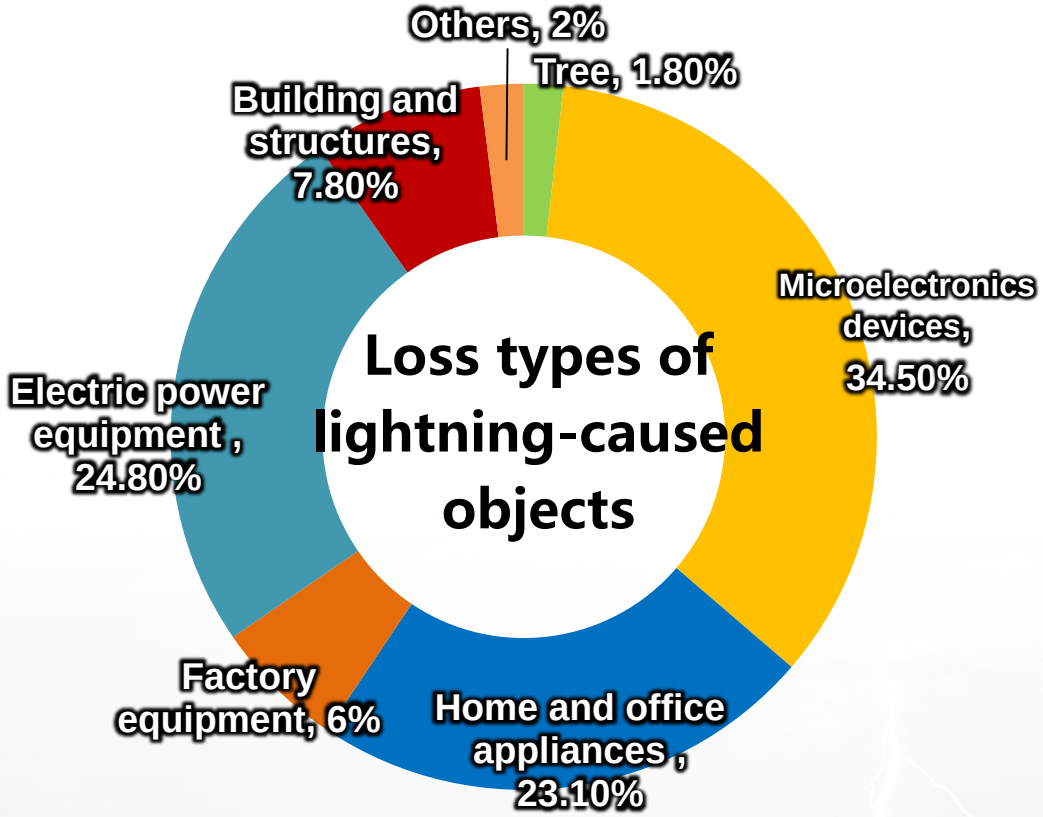

Oil depot Explosion


Power failures

Aviation Loss



Lightning hazards



IEC： Lightning is a great public hazard of the electronic age.

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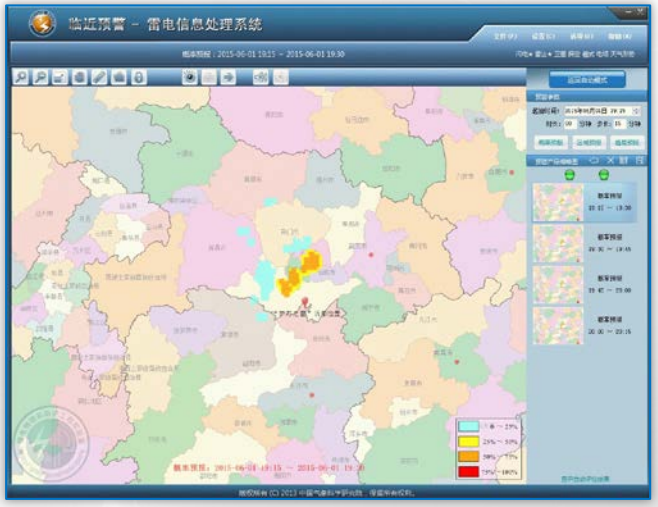
System Introduction

The Lightning Nowcasting and Warning System (CAMS_LNWS) was developed by Chinese Academy of Meteorological Sciences (CAMS). The system proposed a lightning characteristic diagnose and nowcasting scheme in typical regions, and adopted a multi-data, multi-parameter and multi-algorithm lightning nowcasting method.

The CAMS_LNWS work 24 hours every day and renew the warning products every 15 minutes automatically, which can realize 0-1 hours , 1 × 1 km of lightning forecasting.



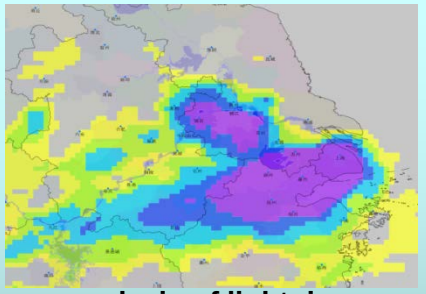
System Introduction

Method

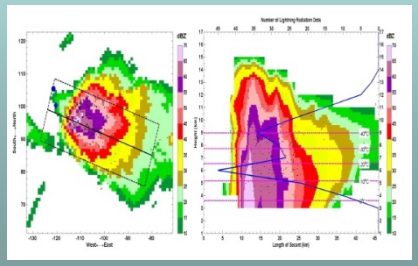
- Analyze the lightning activity in different areas of China
- Obtain the relationship of the lightning frequency and location with the radar, satellite and other observations during a thunderstorm
- Establish the diagnostic indicators of lightning forecasting

Characteristics of lightning activity at different stages. (Lightning Initiation、development、 Ending）

analysis of lightning space-time distribution characteristics



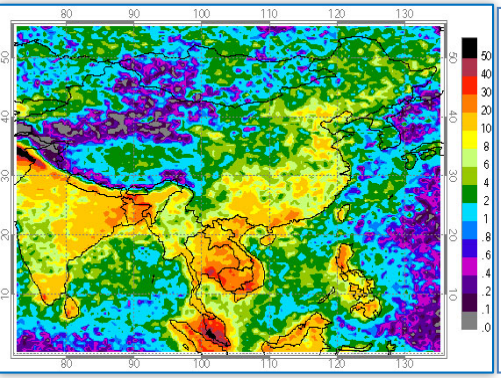
analysis of lightning between and satellite data

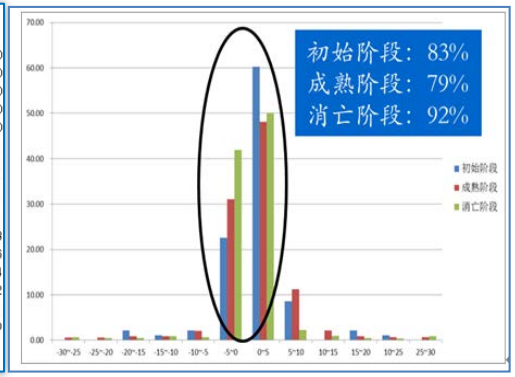


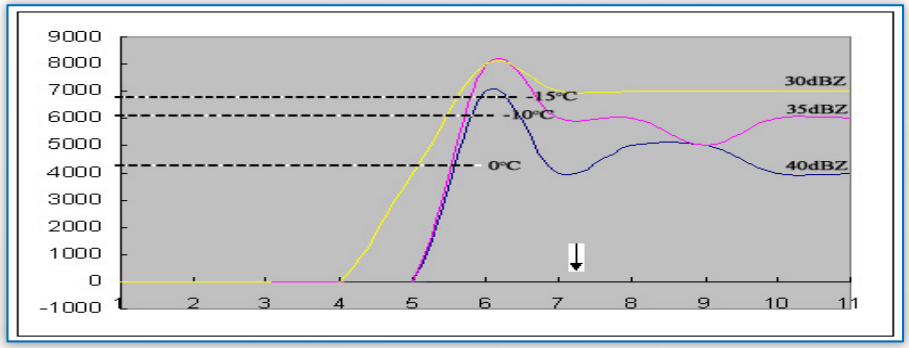
analysis of lightning between and Radar Data

analysis of lightning between and Surface Electric Field Data

System Introduction







Diagnostic Indicators

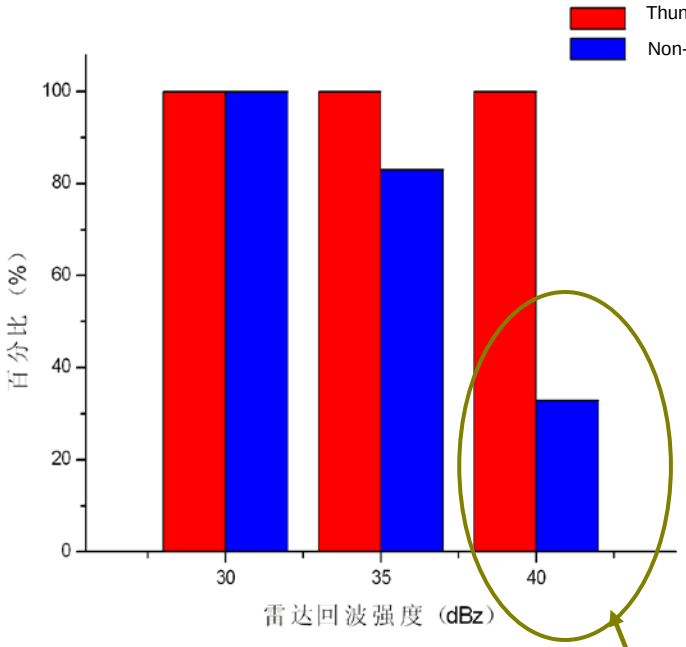
- Height of Radar strong echoes
- Maximum thickness of 35dBz
- Proportion of radar strong echoes
- Distribution of vertical velocity
- Horizontal gradient of composite reflectivity
- Maximum reflectivity within 14km around first stroke of stratiform CG
- Echo volume per flash
- Volume per frequency
- Black-Body Temperature(TBB) of satellite
- Electromagnetic signal threshold
- …

Concerns:

- Lightning Initiation
- Lightning Ending
- Stratiform Regions Lightning

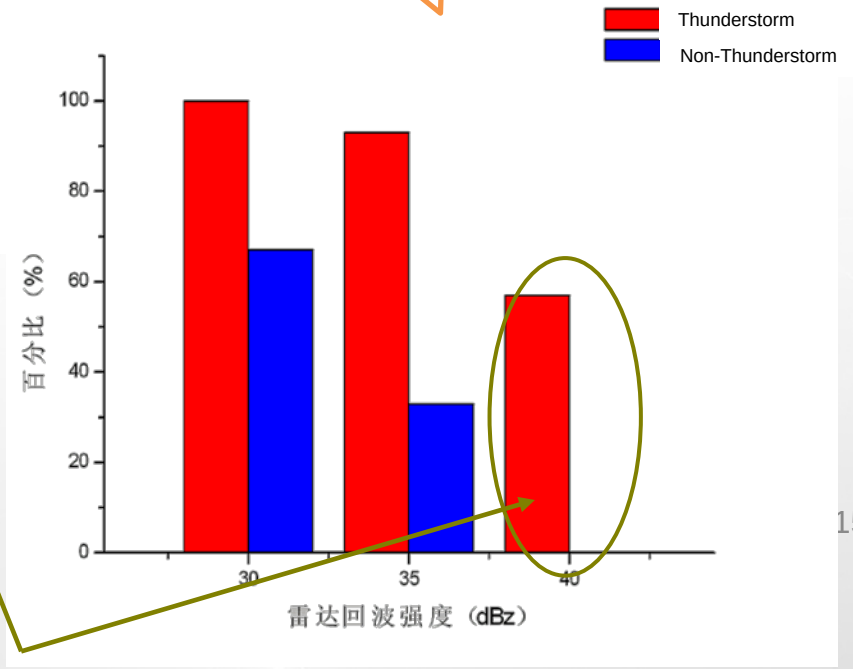
Key Method

➢ Lightning Initiation- **Echo top height of 40dBz ≥ -10℃ stratification height**



Echo top heights of 30、35 40dBz and 0℃ stratification height in different isolated cells

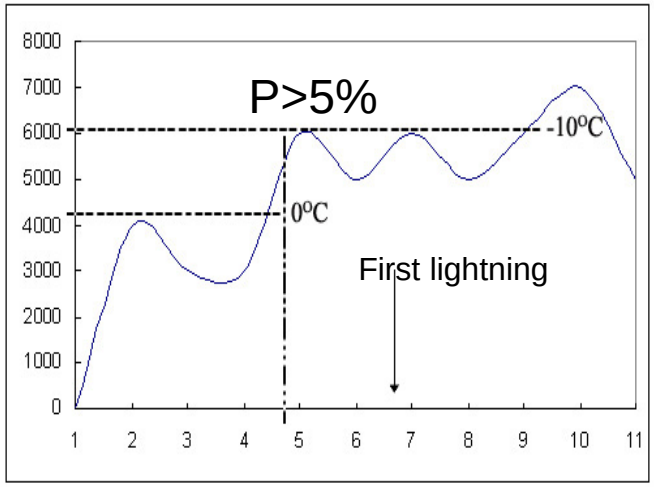
Echo top heights of 30　35 40dBz and -10℃ stratification height in different isolated cells

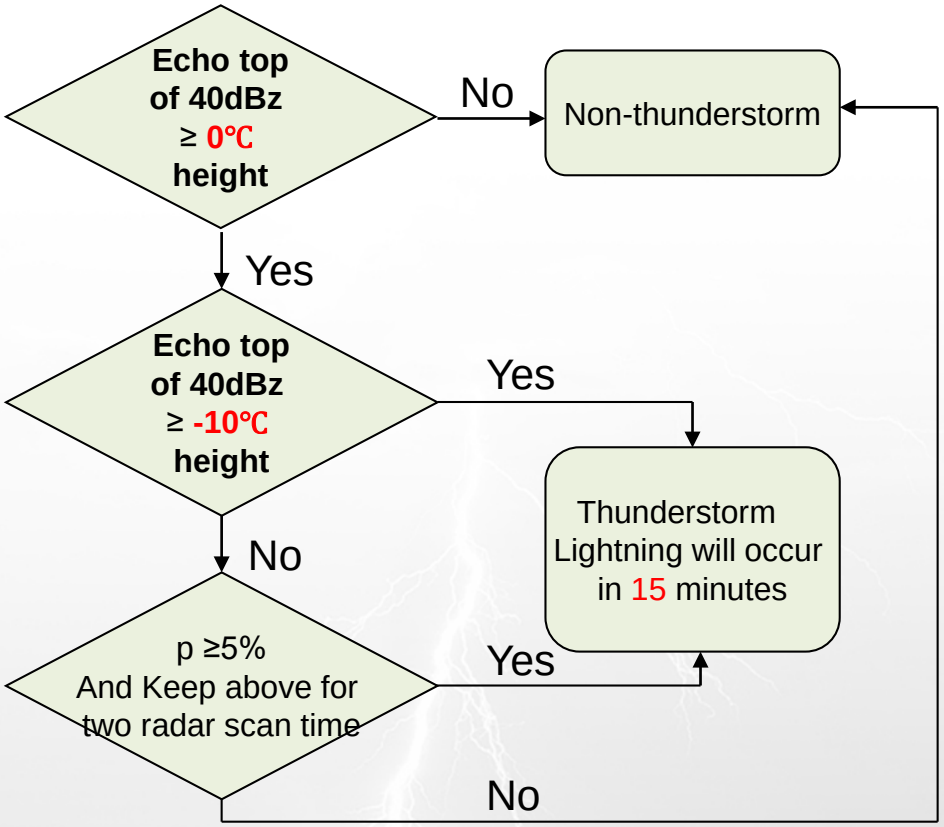


Key Method

- Lightning Initiation- P value should be used for subsidiary discrimination

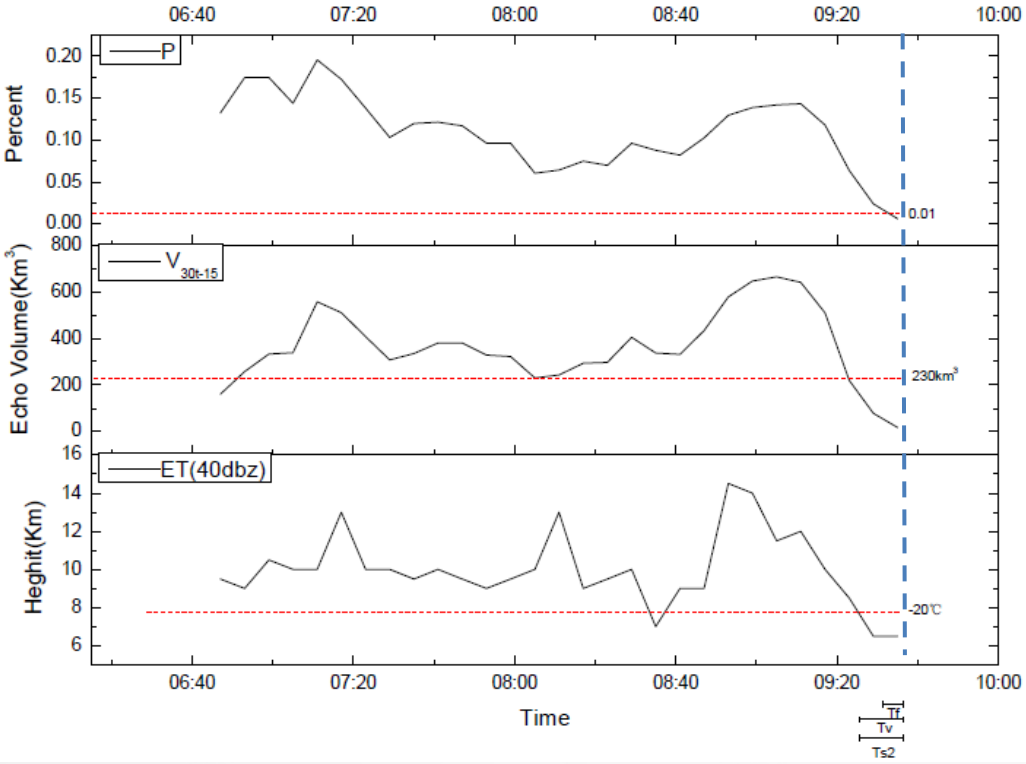
$$P = \frac{\text{Volume (Reflectivity} \geq 40\text{dBz and Height} \geq 0\ ^{\circ}\text{C height)}}{\text{Volume (Reflectivity} \geq 25\text{dBz and Height} \geq 0\ ^{\circ}\text{C height)}} \times 100\%$$





Key Method

- Lightning Ending



$Volume_{30\text{-}15}$/ $Volume_{18}$ < 1%

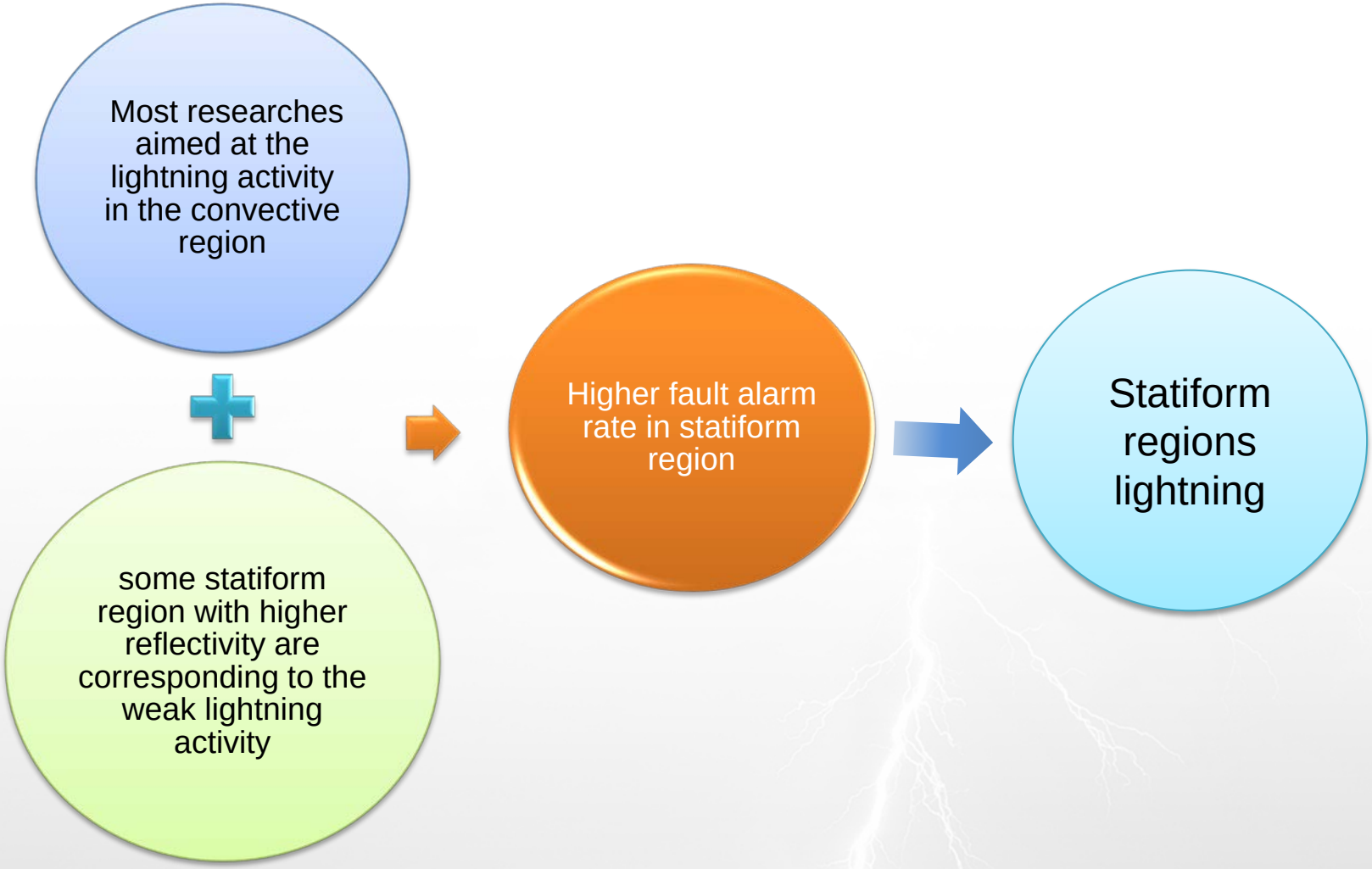
$Volume_{30\text{-}15}$ (Reflectivity ≥30dBz and Height ≥ -15 ℃ height) <230km^3

③ Echo top height of 40dBz < -20℃ height

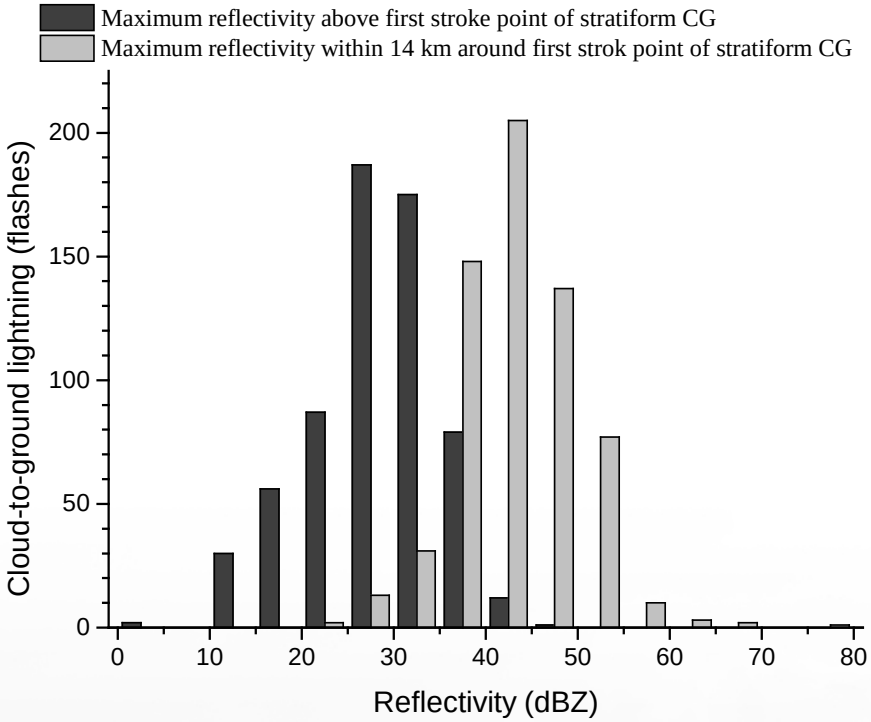
We can combine the conditions of , , to forecast lightning ending.

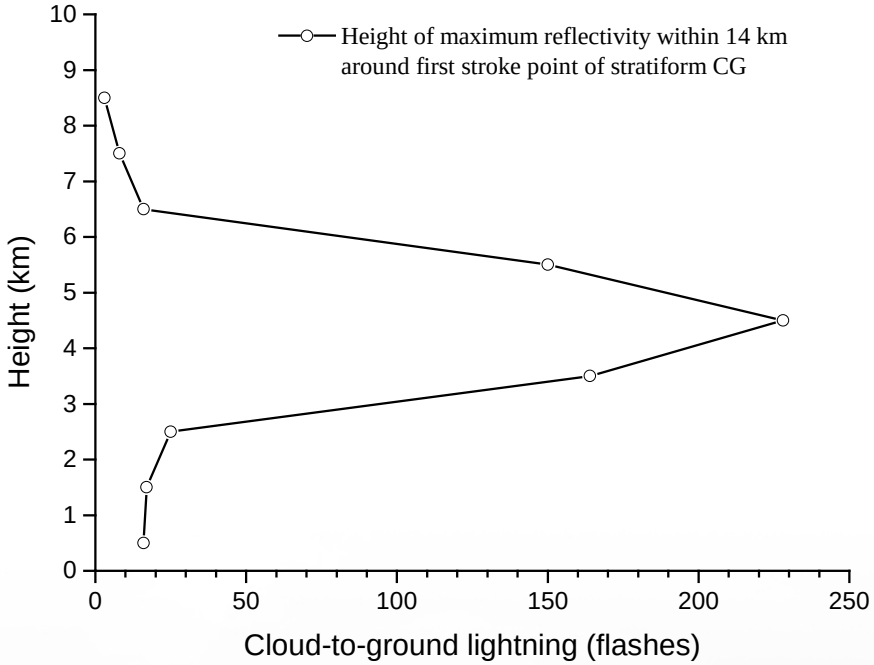
Key Method

- Stratiform regions Lightning

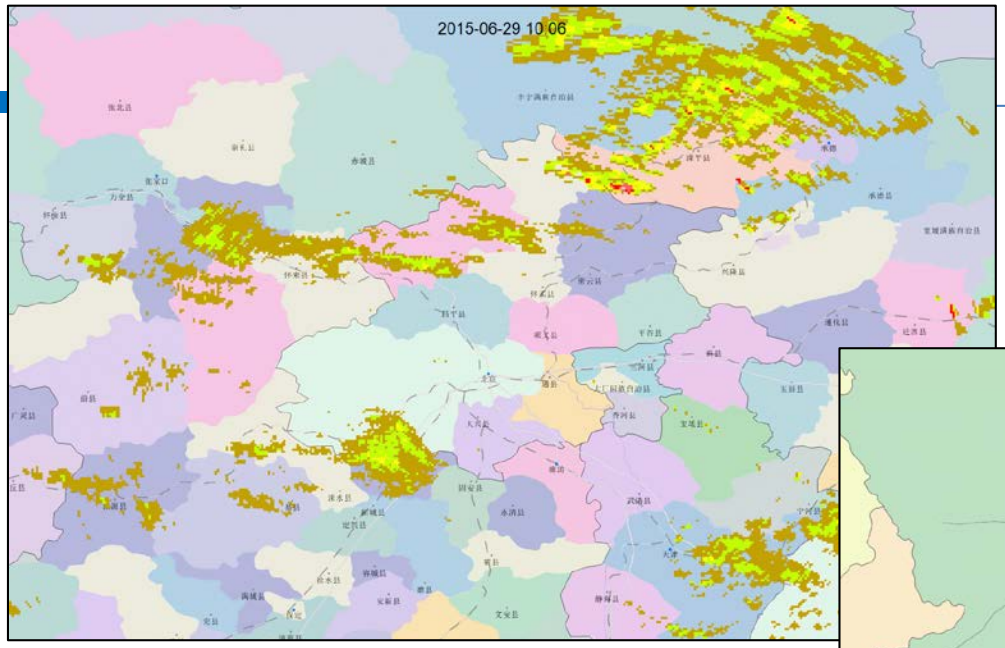


Key Method



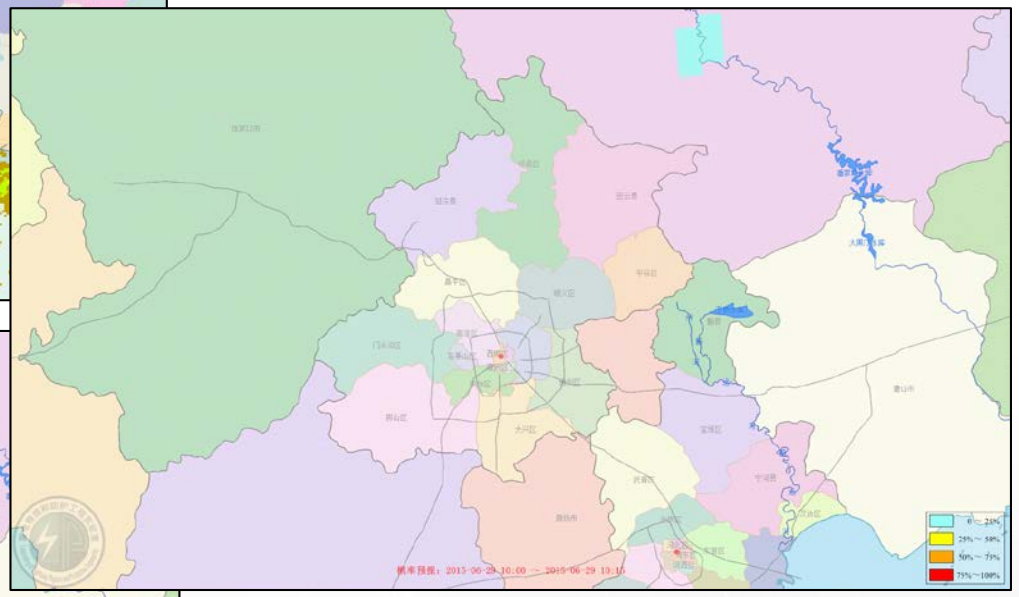


Analyze the Height and maximum reflectivity of stratiform CGs strike the ground at or near the edge of a region, and refer to the distinguish method of stratiform and convective region proposed by Steiner et al. (1995), and later improved by Biggerstaff and Listemaa, zhong, Xiao et al (2007), We adopt identify algorithm to forecast the lightning activity in the stratiform and convective regions.

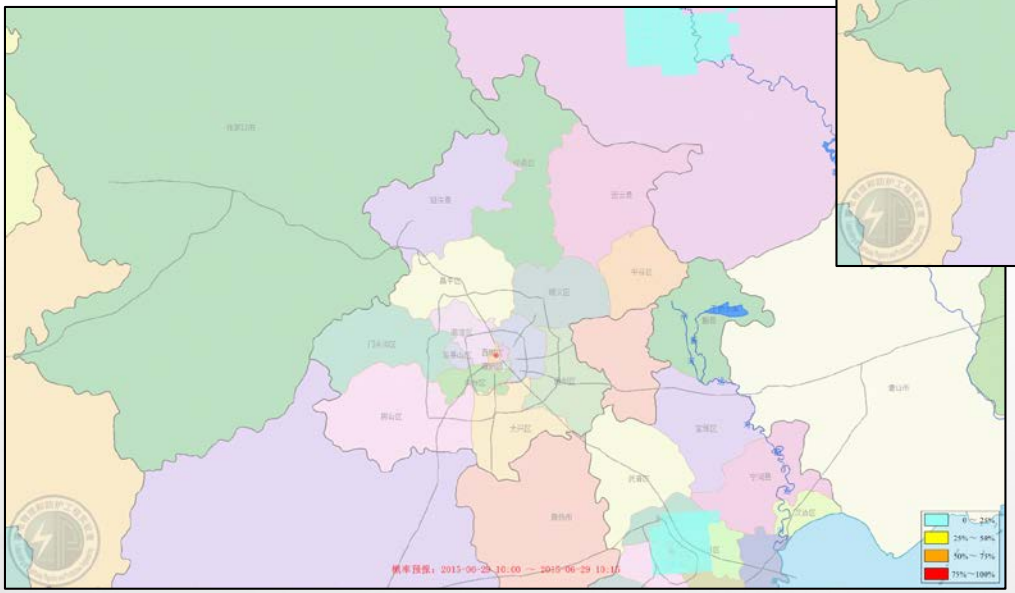


10:00-15:00 Jun 29,2015

Observation

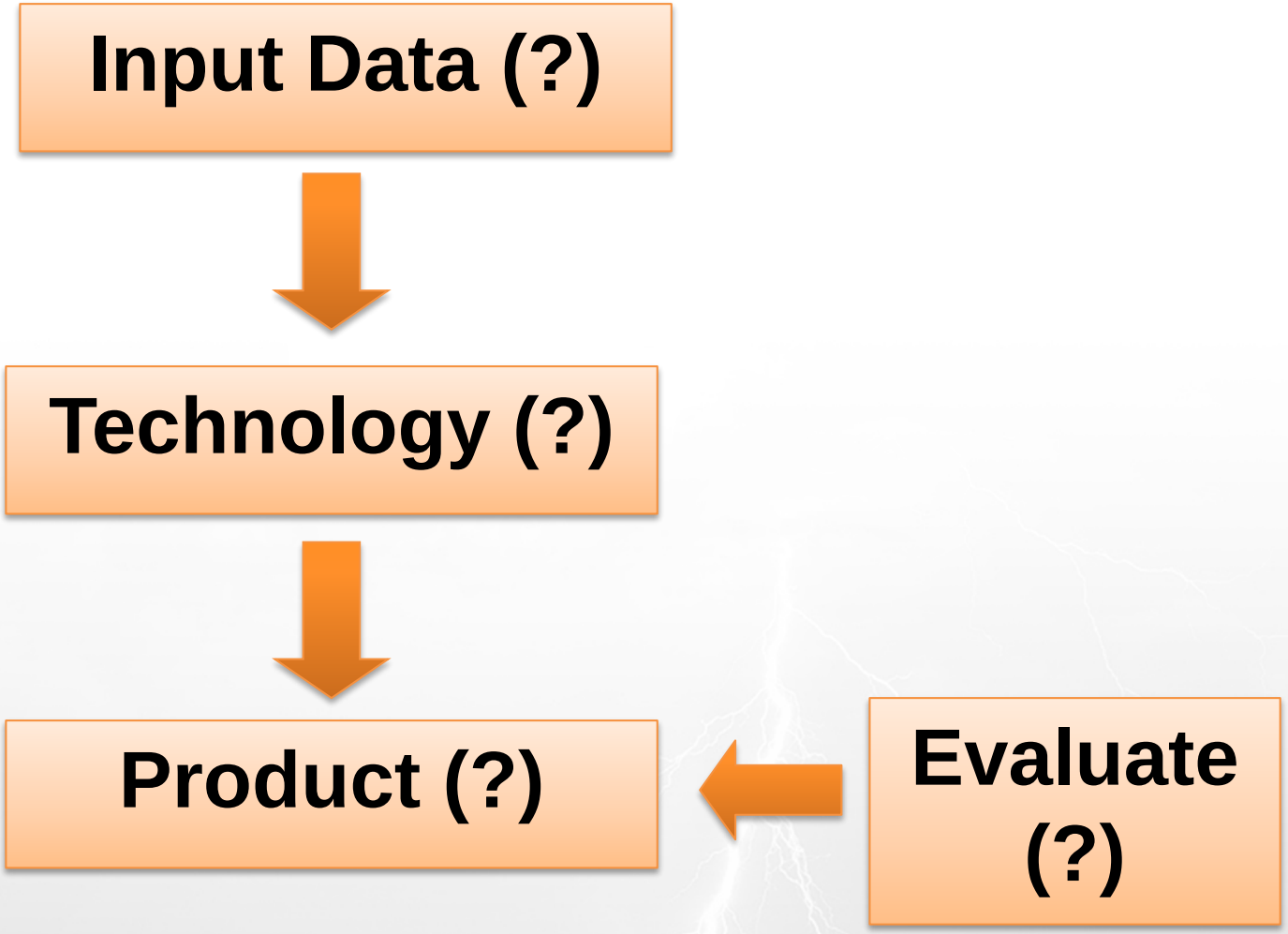


After using the identify method



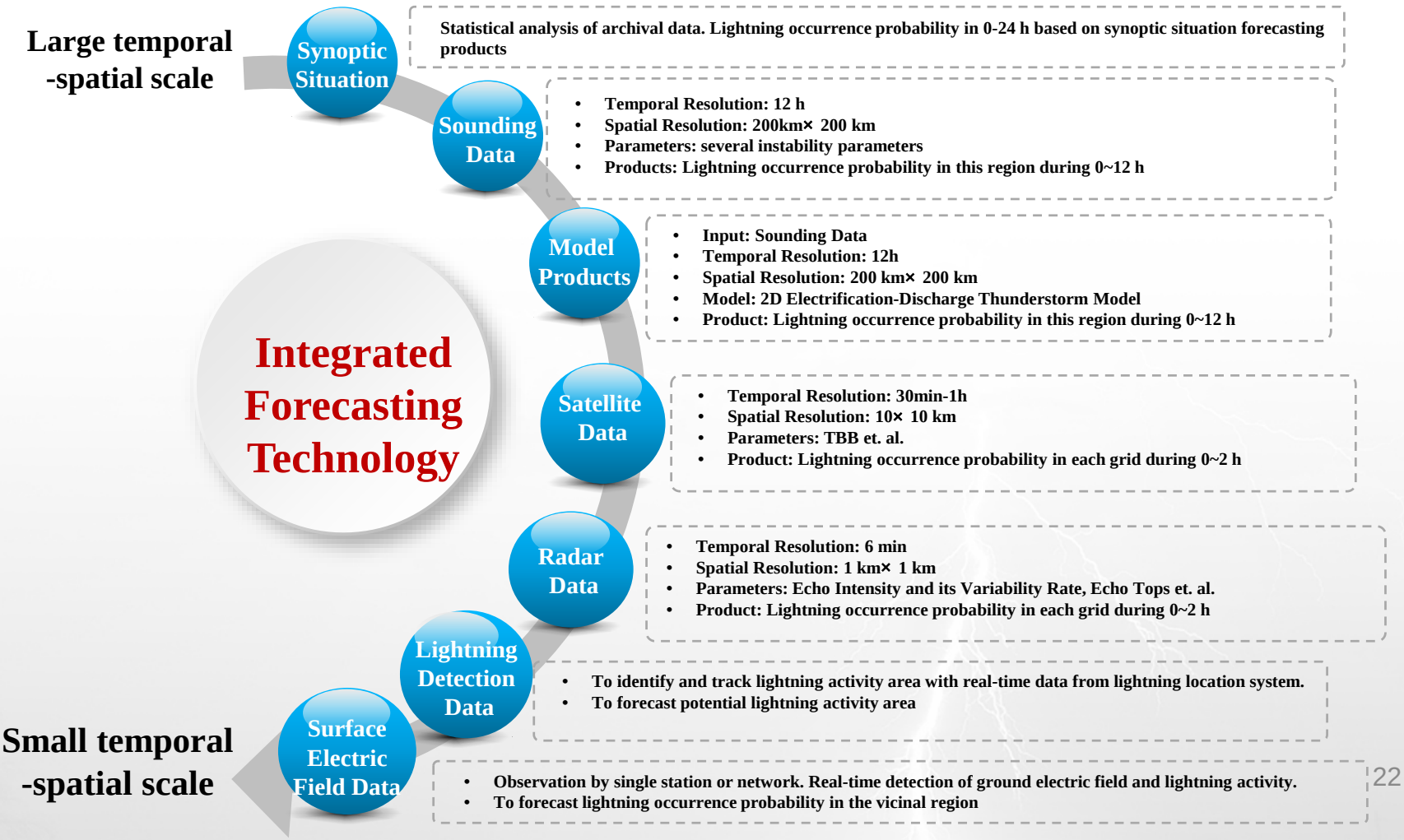
Before using the identify method

Design Scheme



Technology

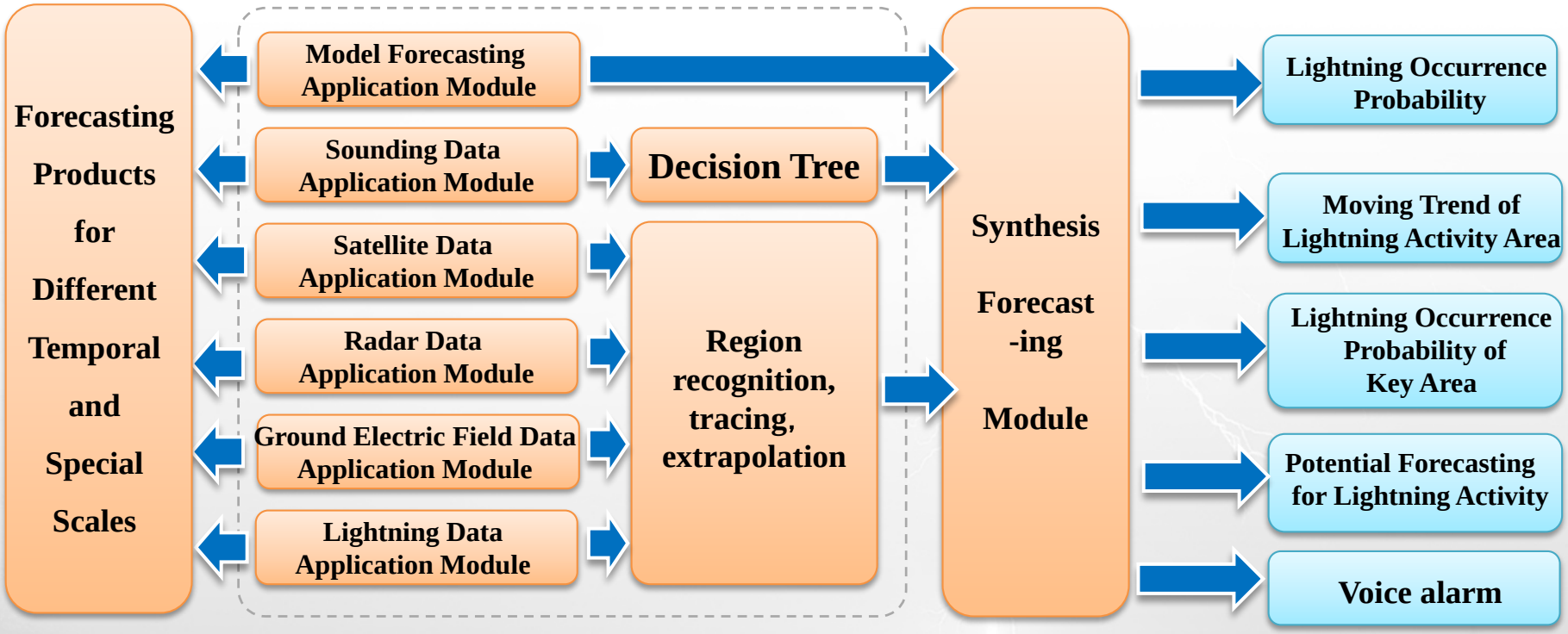
Input Data Multi-source observation data: sounding data, satellite, radar, lightning, surface electric field data and so on.(from large temporal spatial scale to small temporal spatial scale)



Technology

Technology

- The system was designed in framework and modularization.
- Based on algorithm of area identification, tracing and extrapolation algorithm and decision trees algorithm
- Considering different data situation, the system can not only use single data application module to produce forecasting result for different temporal and special scales, but also synthesis different application module to generate products through weight combination method.

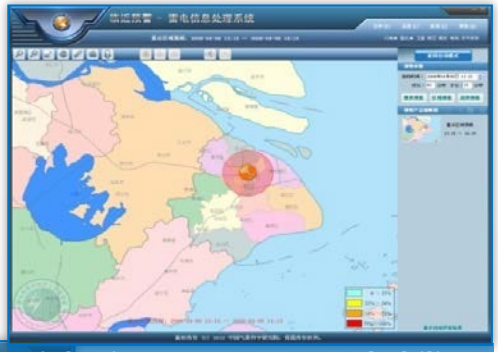


Technology

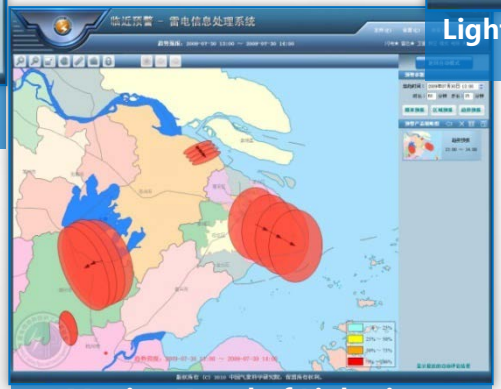
Product

In order to meet the different needs of public meteorological service and special meteorological service, three kinds of Lightning nowcasting and warning products were showed. In order to make an objective assessment of result, we also evaluate the accuracy of the warning products by Probability of Detection (POD), Fault Alarm Rate (FAR) and Threat Score (Ts).

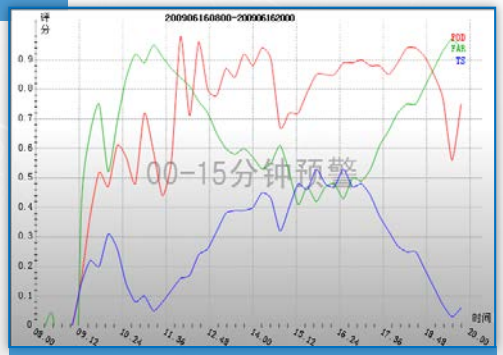
Lightning Occurrence Probability



Lightning Occurrence Probability of Key Area



Moving Trend of Lightning Activity Area



Evalution of pruducts in real time

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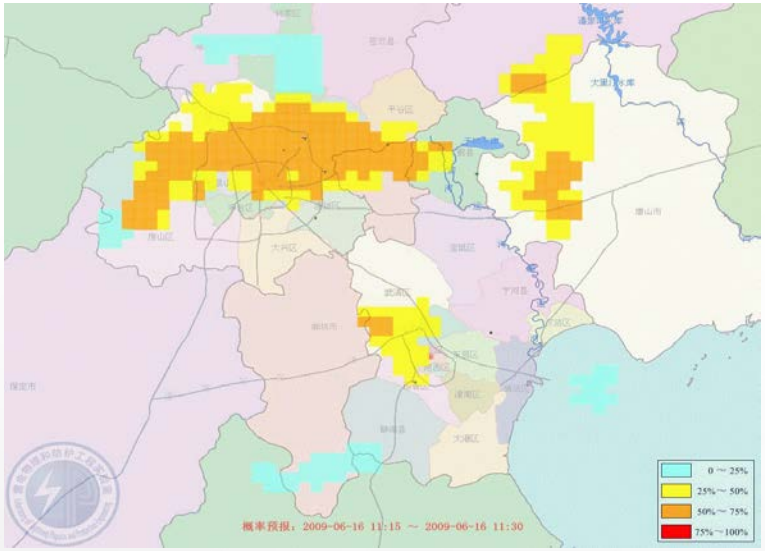
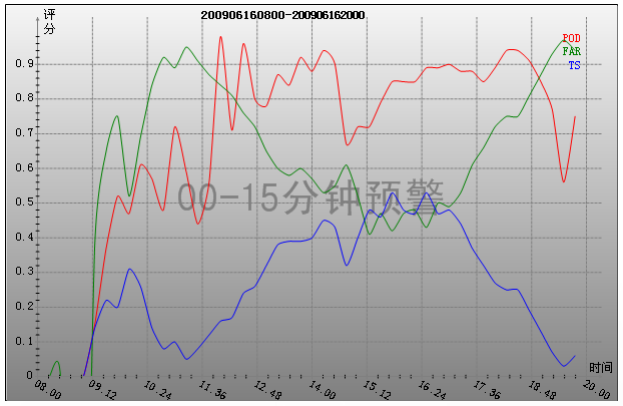
CAMS_LNWS Application

Tianjin: 11:00-20:00, June 16, 2009 . Severe weather hit Tianjin, with thunder storms, heavy rainfall and strong winds.



Forecast results in 15minutes intervals



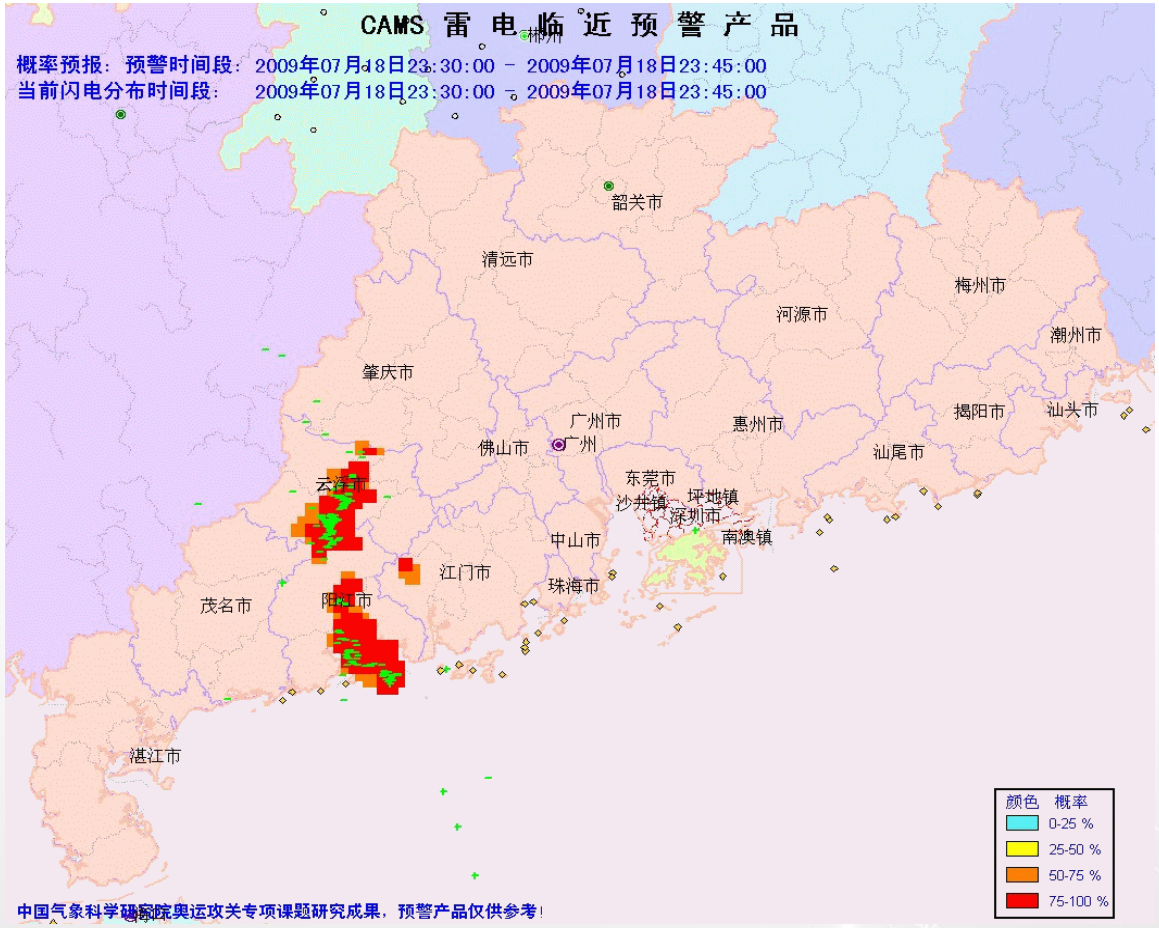
	Mean value	Sample number
POD	0.81	36
FAR	0.67	
TS	0.31	

Evaluation results

Case of Tianjin

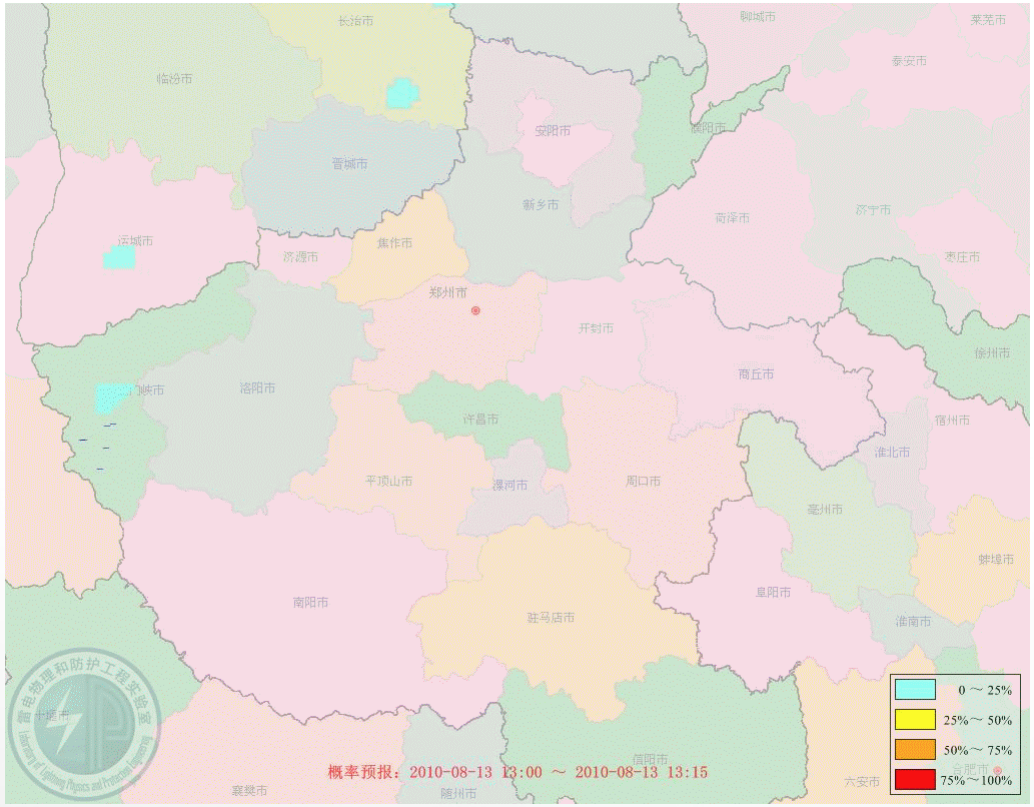
CAMS_LNWS Application

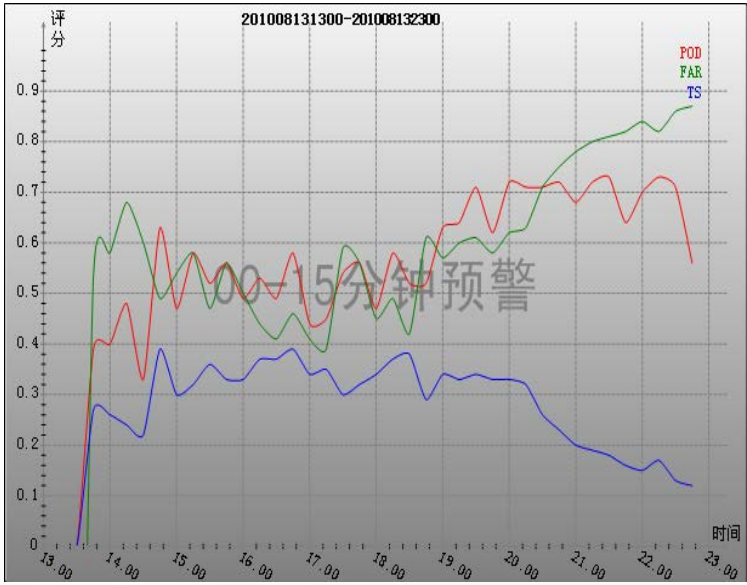
Guangdong： 16:00-23:45, July 18, 2009.



Case of Guangdong in Southern China

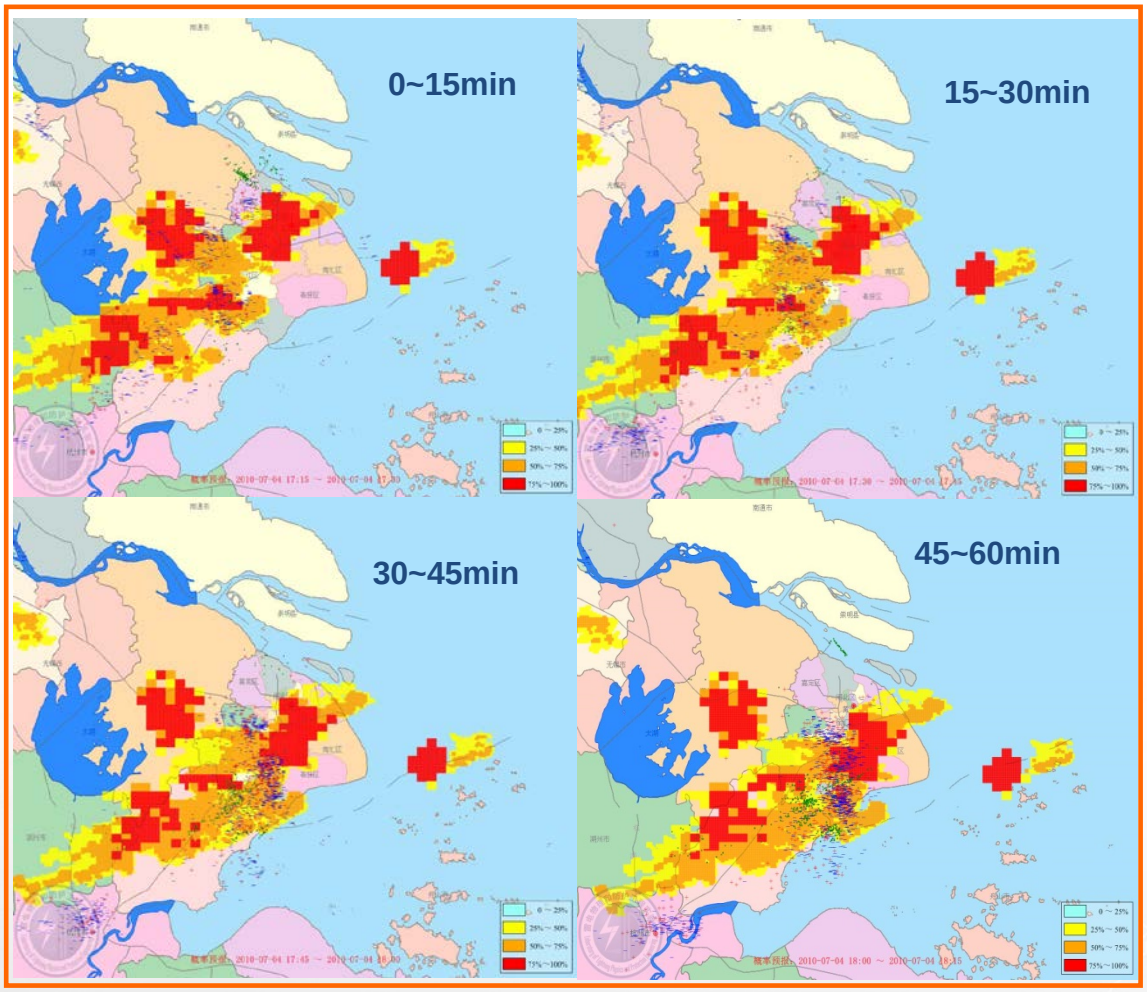
CAMS_LNWS Application

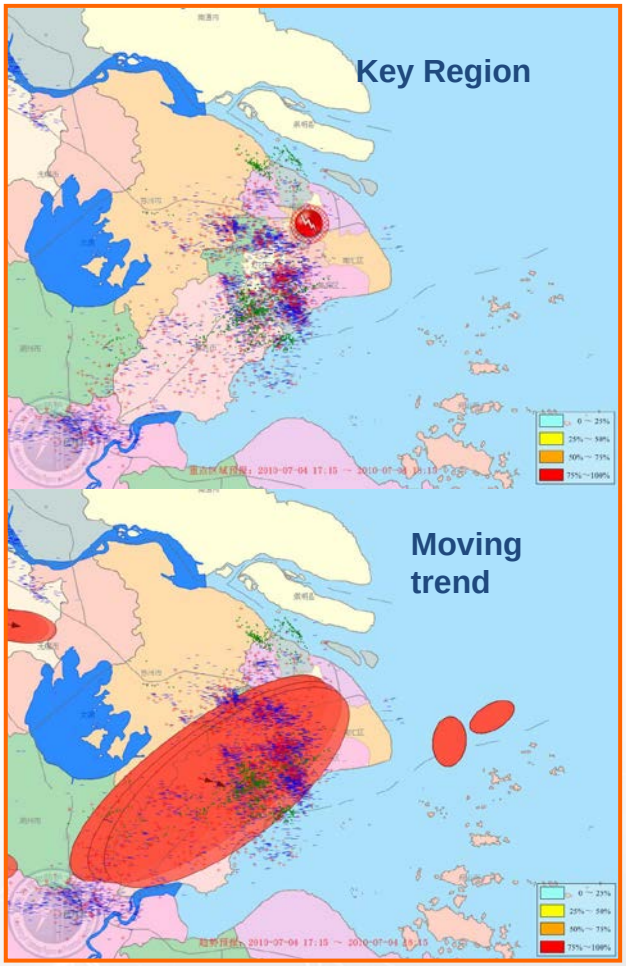




Case of Henan in central of China

CAMS_LNWS Application





Case of Shanghai during the World Expo2010.

CAMS_LNWS Application

Public services

- Lightning nowcasting and warning products

Application for public meteorological service

Special service

- forestry
- Electric power
- Tourism
- Telecom
- ……

Application in forestry department

Application in electric power department

CONTENTS

Future Work

0～2h lightning nowcasting

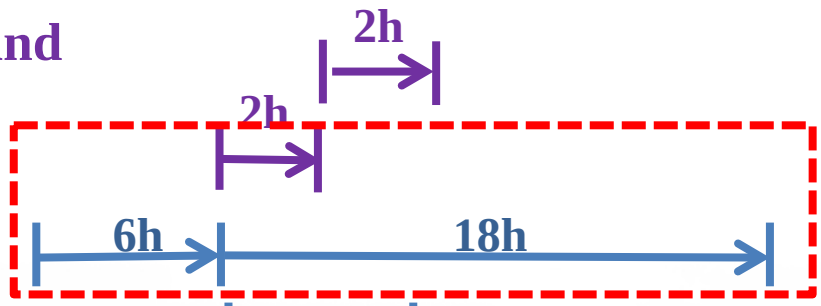
Regional lightning nowcasting index and algorithm should be improved further to decrease FAR.

0　6h lightning short-term forecast

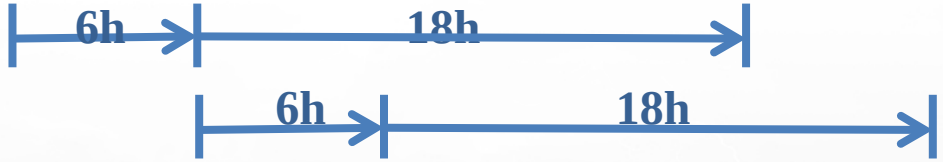
Developing the coupling of charge-discharge model of thunderclouds with meso-scale model to develop a 0~6 hour numerical forecasting method.

Future Work

Lightning nowcasting and warning system



Lightning numerical Prediction system



Lightning potential forecasting system


Thank you!