Yale 耶鲁大学-南京信息工程大学大气环境中心
Yale-NUIST Center on Atmospheric Environment

Numerical Simulations of the Ice Accretion Process on Transmission Lines

Gao Yaqi

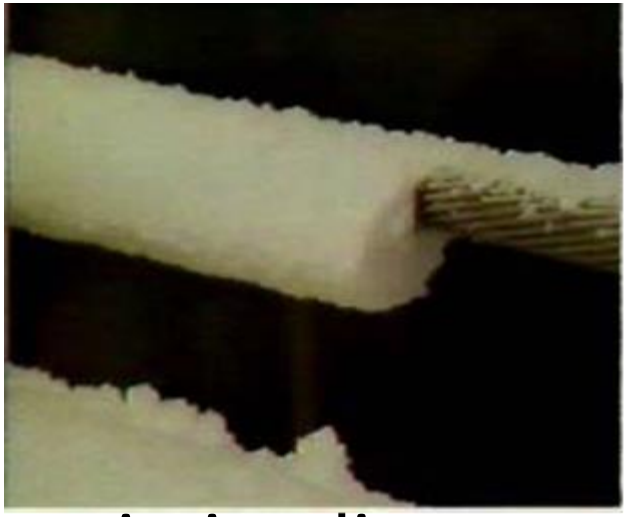
2015,07,24

Outline

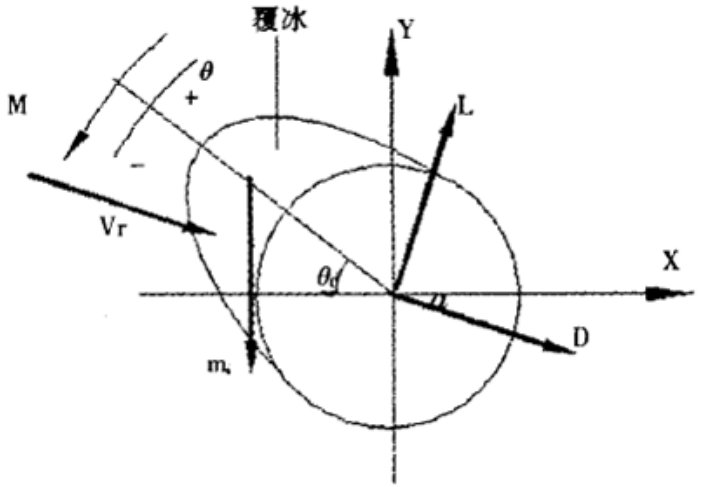
- Background
- Data and method
- Preliminary simulated results
- Next work

Background

- transmission line icing



- ice coating galloping of transmission line



Background

- Jones (1998) estimated ice accretion thickness using a simple ice accretion model.

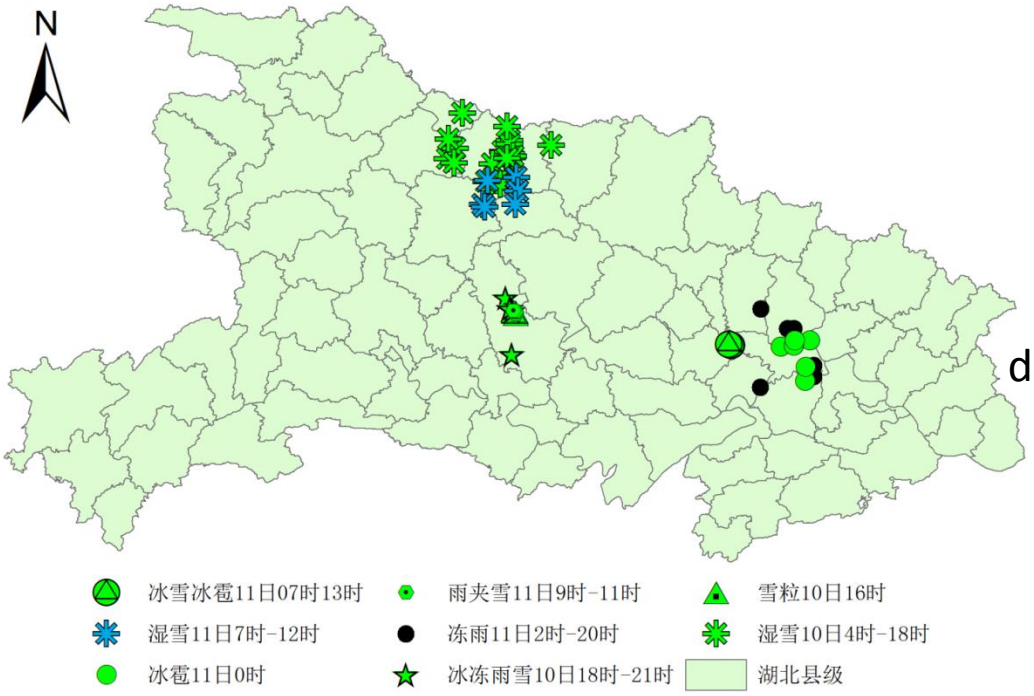
$$R = \frac{1}{\rho_i \pi} \sum_{j=1}^{N} [(P_j \rho_0)^2 + (3.6 V_j W_j)^2]^{\frac{1}{2}}$$

P: precipitation rate (mm h^{-1}), *W*: liquid water content, *j*: time

- Farzaneh (2000) discussed the mechanism of the freezing process of supercooled water droplet impacting on wires, and calculated coefficient of collision, capturing and freezing by wind tunnel test and physical models. Based on these results, Makkonen (2008) establish the wire icing model, used to estimate ice thickness.
- Degaetano et al. (2008) use WRF to forecast short-term ice accretion for electric utilities, but it is only for freezing rain.

Background

- The basic situation ice coating galloping of transmission line in February 2010 in Hubei province



53 stations with ice coating galloping of transmission line during February 10th to 11th , 2010

- Weather observed data from state meteorological administration could not reflect these weather phenomena. Accurate forecasting use WRF can provide scientific basis for disaster prevention and reduction of power facilities.

Data and method

- Micaps data
- observational precipitation
  (daily merged precipitation dataset)
- WRF V3.4.1

Data and method

- Microphysics scheme

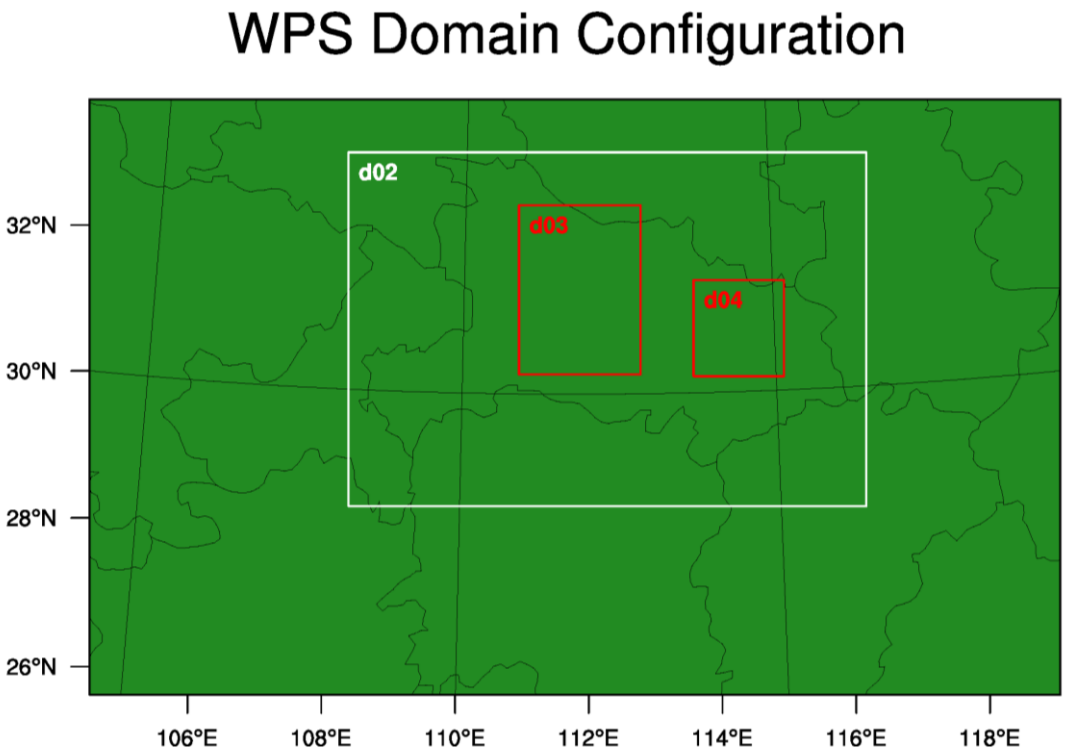
  Lin
  WSM6 → single parameter scheme

  Thompson → double parameter scheme

- Planetary boundary layer physics scheme

  YSU
  ACM2 → non-local closure

Model domain



Time	2010-02-09 14:00 ~2010-02-12 00:00
Grid number	D01：166×102； D02：265×181； D03：187×259； D04：139×148；
Horizontal resolution	D01：9km； D02：3km； D03：1km； D03：1km；
Geog resolution	Modis +10min; Modis +2min; Modis +30s; Modis +30s;

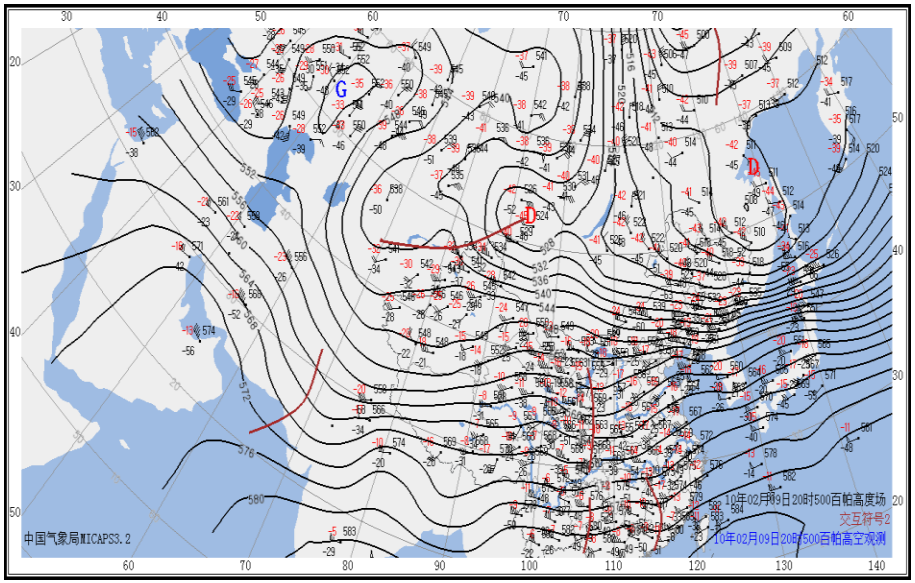
Sensitivity test

Initial condition meteorology	NECP (6h 1° ×1°)
Longwave radiation scheme	RRTM scheme
Shortwave radiation scheme	Dudhia scheme
Cumulus parameterization scheme	shallow convection Kain-Fritsch (new Eta) scheme（D01）
Land surface model	Noah land surface model
Surface layer scheme	Monin-Obukhov scheme

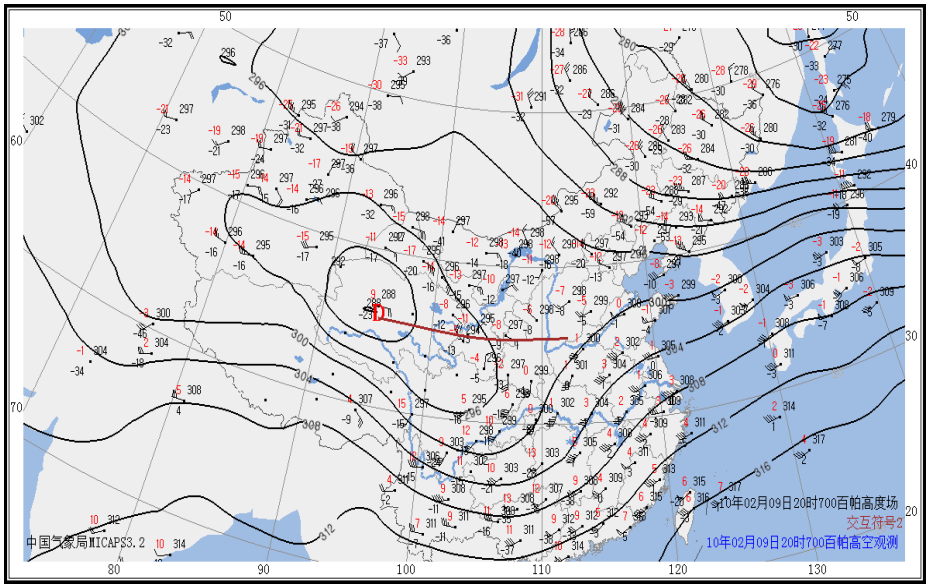
	Microphysics scheme	**Pbl physics scheme**
Case - 1	Lin	YSU
Case - 2	WSM6	YSU
Case - 3	Thompson	YSU
Case - 4	Lin	ACM2
Case - 5	WSM6	ACM2
Case - 6	Thompson	ACM2

Weather situation—2010,2,9 20:00

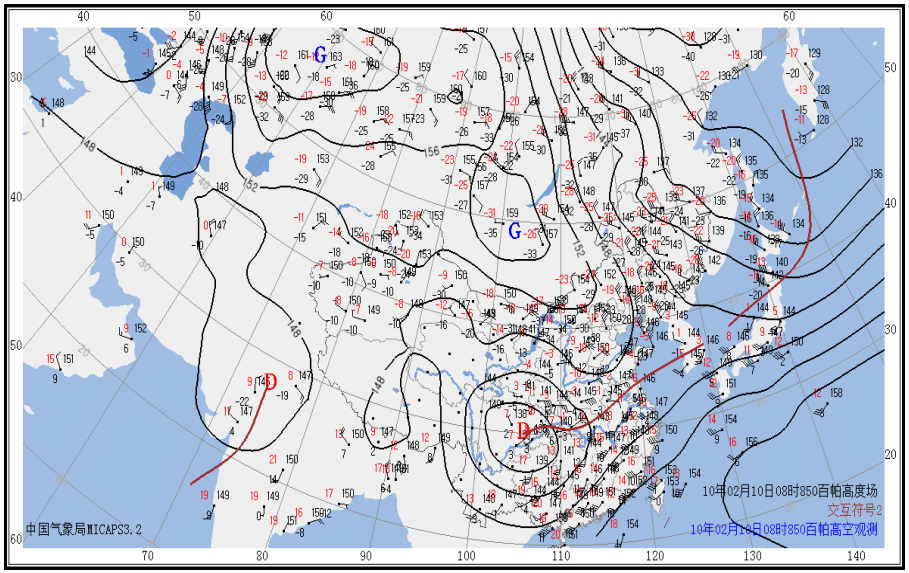
500hPa



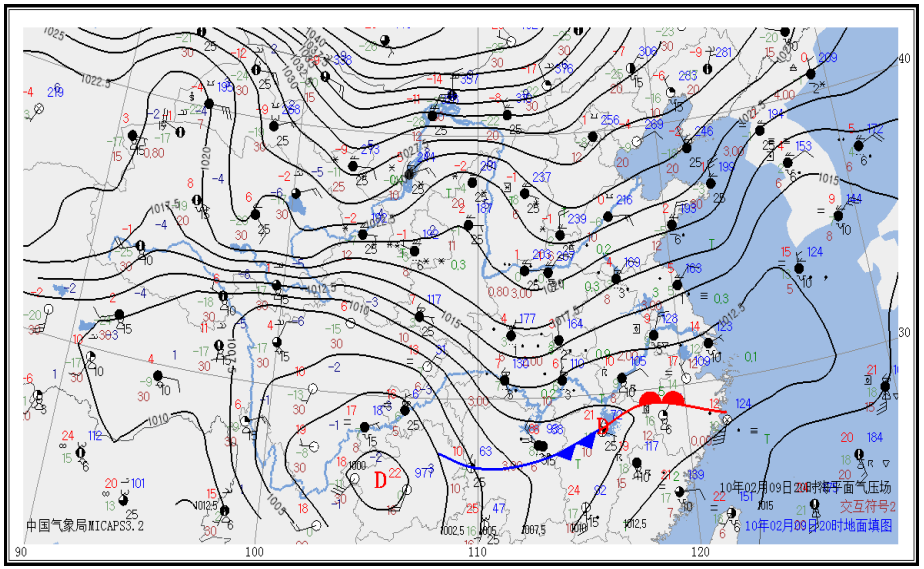
700hPa



850hPa



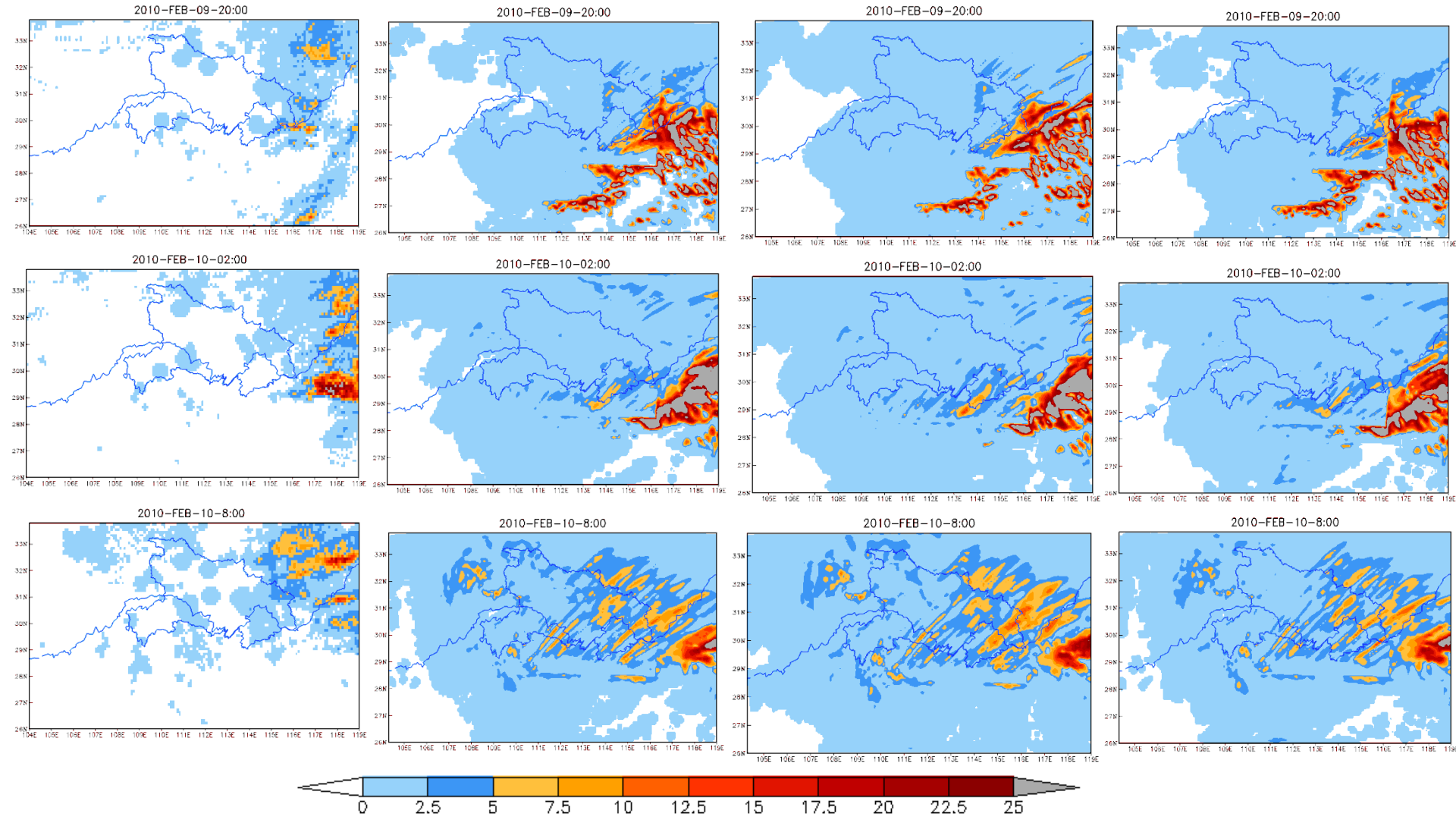
surface

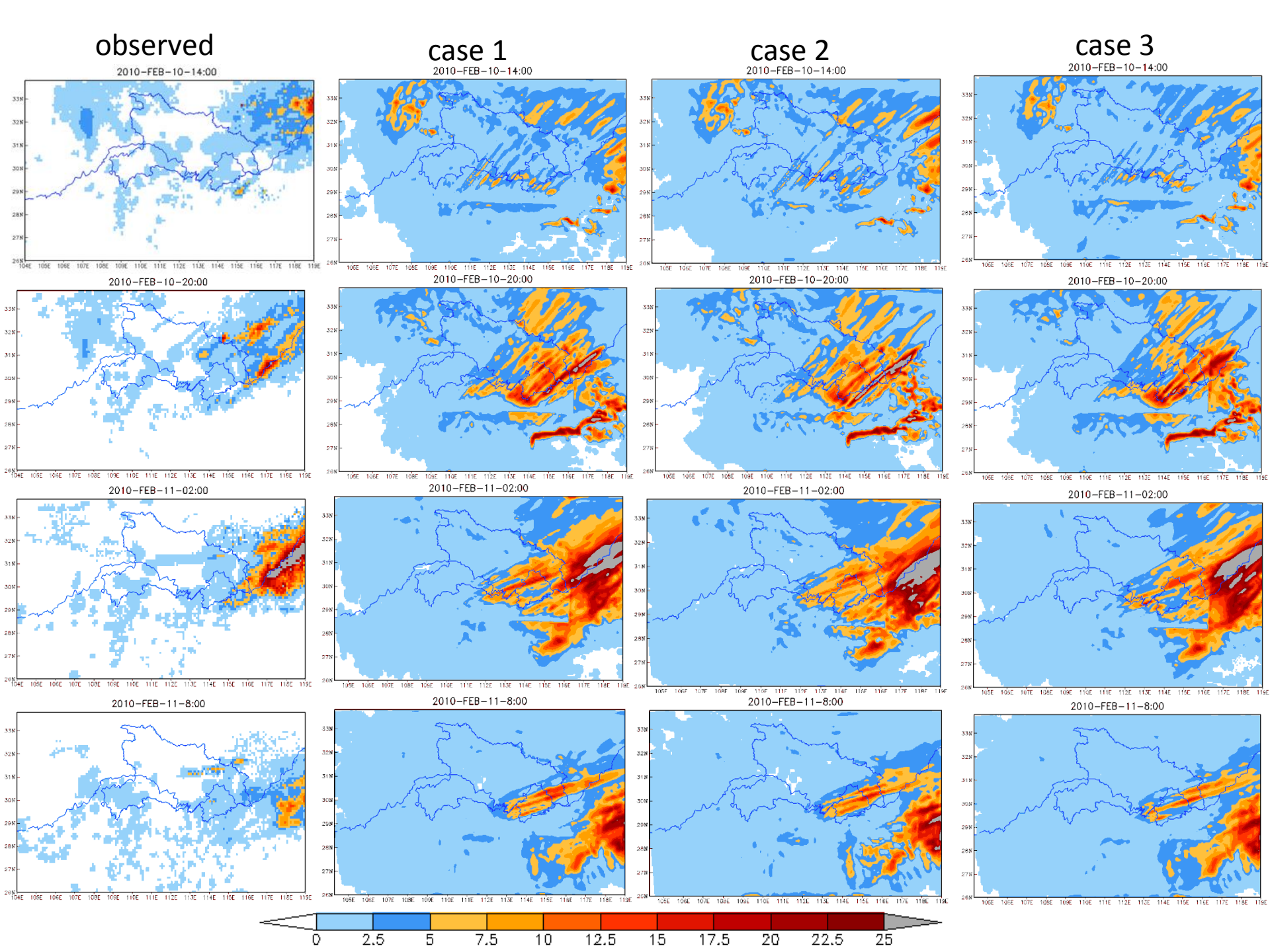


Preliminary Simulated Results

6-h accumulated rainfall

observed | case 1 | case 2 | case 3

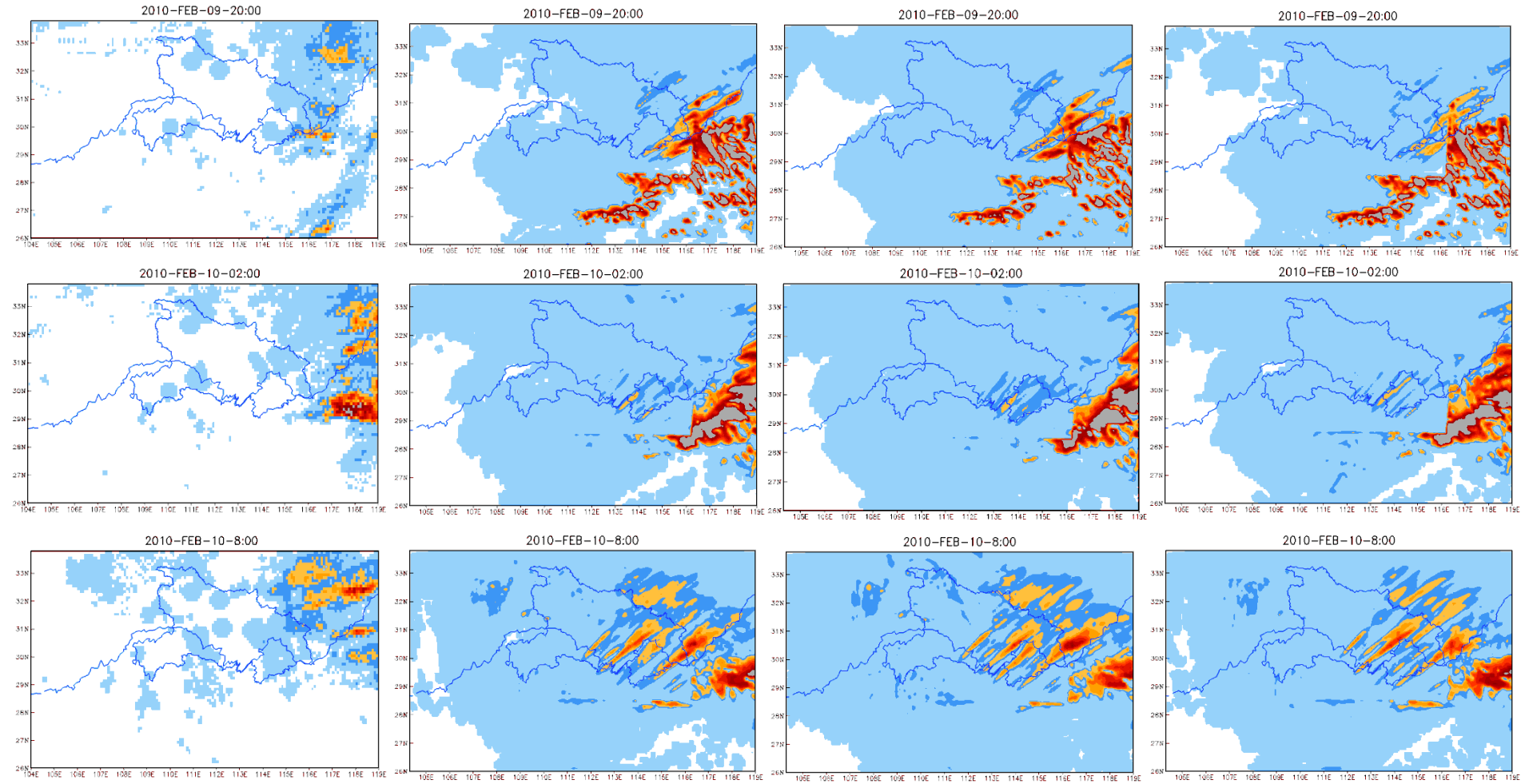


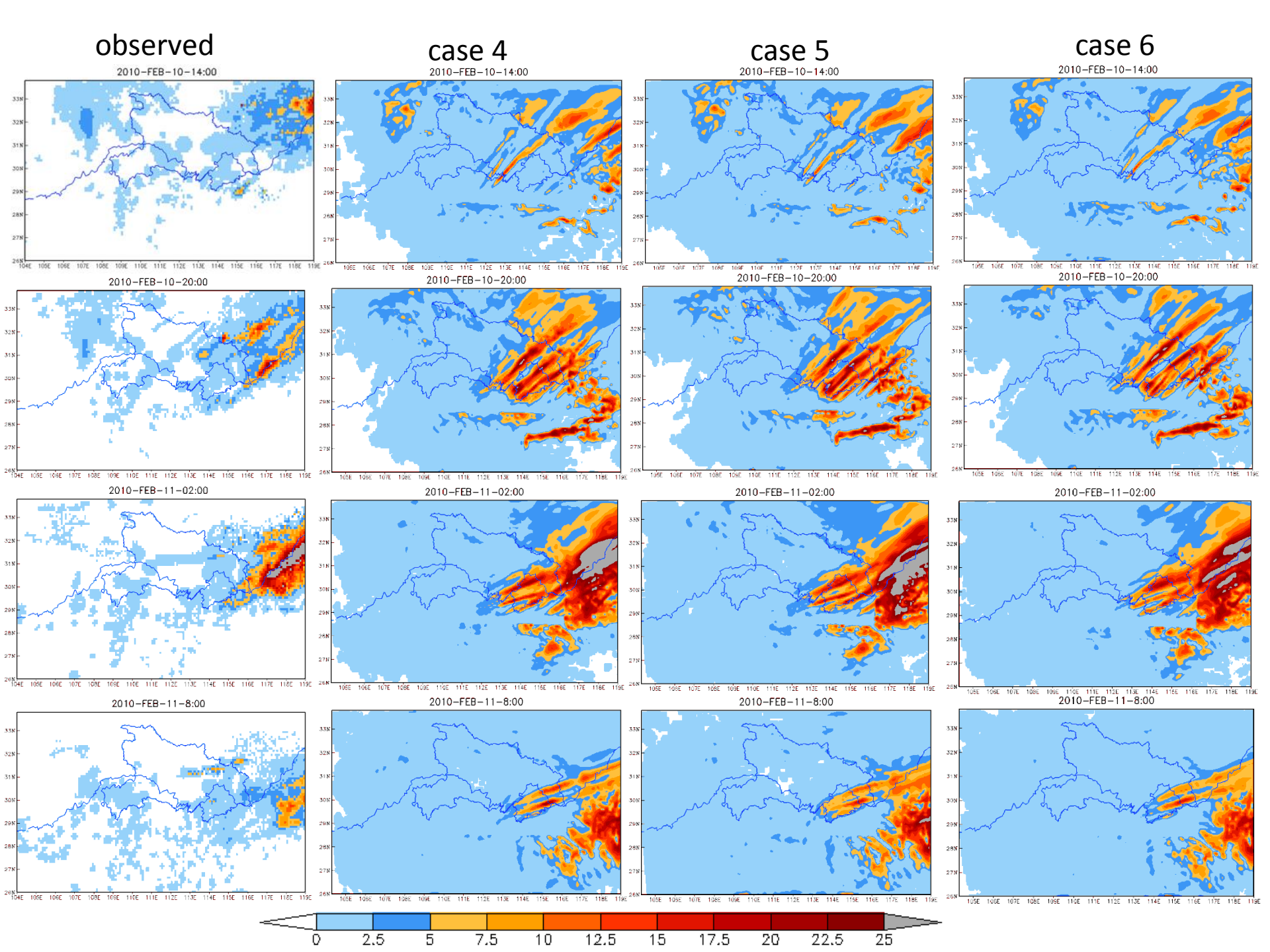

observed
case 1
case 2
case 3
2010-FEB-10-14:00
2010-FEB-10-20:00
2010-FEB-11-02:00
2010-FEB-11-8:00
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25

Preliminary Simulated Results

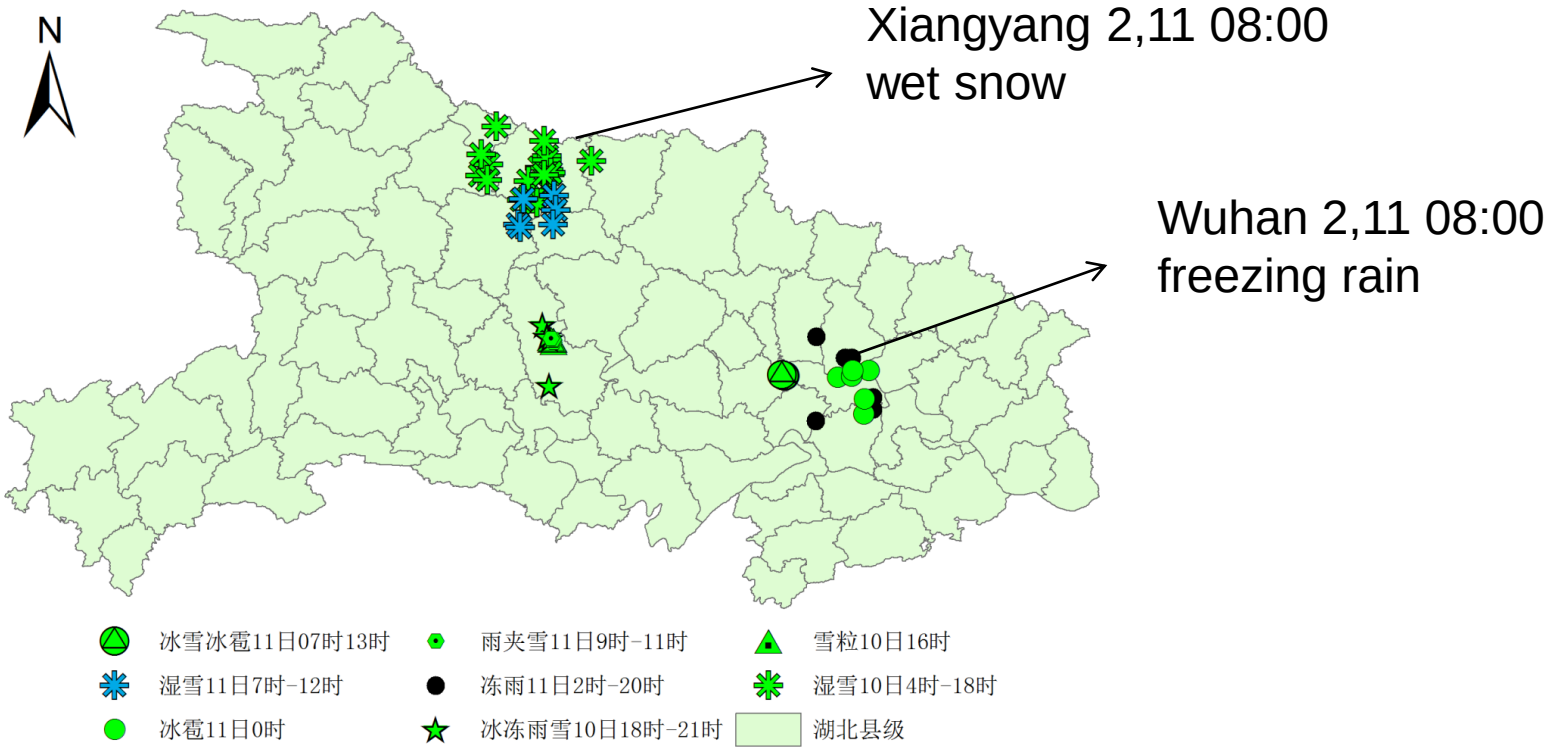
6-h accumulated rainfall

observed | case 4 | case 5 | case 6




observed
case 4
case 5
case 6
2010-FEB-10-14:00
2010-FEB-10-20:00
2010-FEB-11-02:00
2010-FEB-11-8:00
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25

Weather phenomena

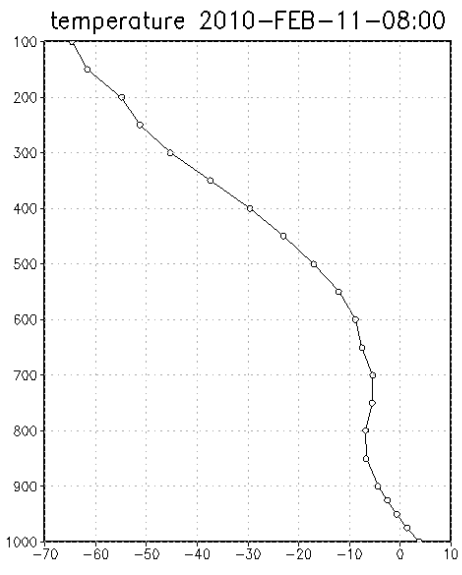


Weather phenomena in 53 stations with ice coating galloping of transmission line during February 10th to 11th , 2010

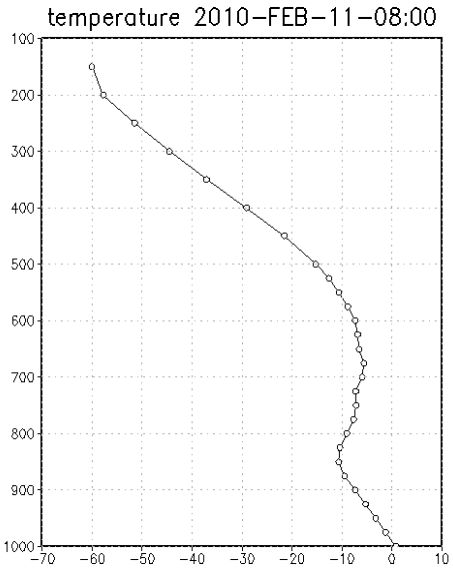
Simulated Results

Xiangyang : wet snow

observed

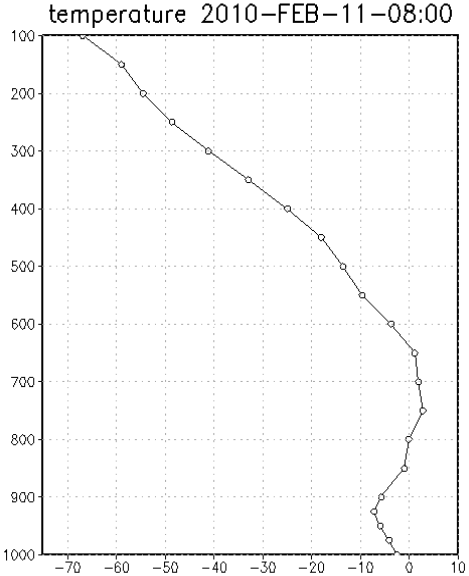


case 3

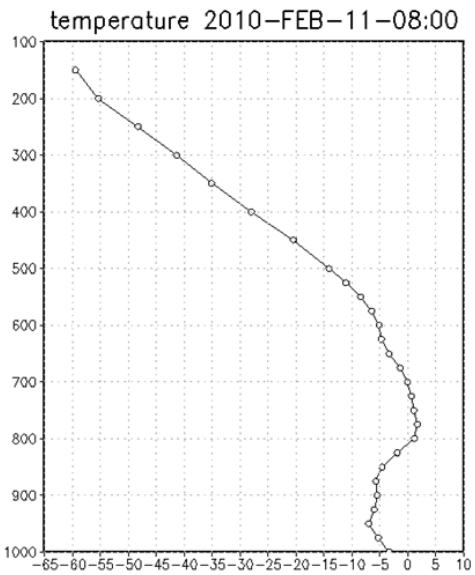


Wuhan : freezing snow

observed



case 3



Next work

- Adjust the WRF domain and physics schemes for better simulated rainfall.

- Evaluate the wind to simulate ice coating galloping of transmission line, and seek forecast factors to judge galloping.

Thank you